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LITERARY CONTENTS.

	Page
LEADERS	607-616
Industrial Aspects of the "French Shore" Question	607
The Purchase of the Leyland Line Steamers	610
Electric Traction and Electrolysis	611
Commercial Prospects in South Africa ..	612
Thames Traffic	614
British Coal	615
EDITORIAL OPINION	617-620
ARTICLES Specially Contributed by the World's Experts	621-673
The Automatic Transmission of Material. Archibald J. S. B. Little	621
The Development of the Ferranti Rectifier. W. E. Warrilow	639
The Town Refuse Problem, and its Relation to Steam Production. W. H. Maxwell, Assoc. M. Inst. C.E.	648
Gold-Mining Machinery. Philip R. Björling	664
MACHINERY APPLIANCES AND PROCESSES ...	674-684
The Thornycroft-Marshall Water-Tube Boiler	674
Birkenhead Electric Tramways	678
New Radial Drilling Machine	679
A Highly-Effective Boiler and Pipe Covering	679
Joy's Assistant Cylinder	681
An Improved Lathe for "Facing" the Flanges of Cast-iron Pipes	683
The S.S. "Celtic"	684
SOME LESSONS OF THE RAILWAY ACCIDENT AT SLOUGH. A. G. Robins	685
WORKSHOP PRACTICE	690-693
INDUSTRIAL PROGRESS	694-699
THE WORLD'S INDUSTRIAL ENGINEERING PRESS	700-706
REVIEWS	706
BOOKS RECEIVED	706

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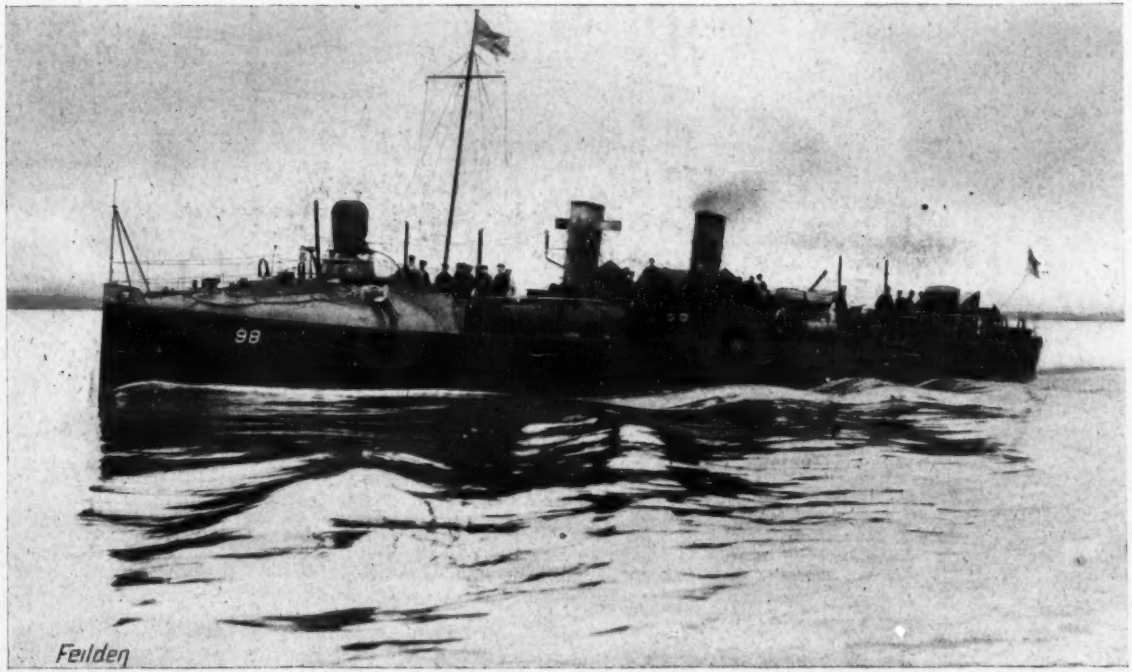

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FEILDEN'S MAGAZINE.

23rd Issue. JUNE, 1901. Vol. 4. No. 6.

Industrial Aspects of the "French Shore" Question.

THERE is reason, of course, to be satisfied that the Legislature of Newfoundland, in recent special session, have agreed to renew for another year the *modus vivendi* with France. This serves to relieve the tension for the time being, and to give Mr. Chamberlain an opportunity to renew negotiations, which have been practically suspended for the twelve-months or more during which France was having her periodic dose of Anglophobia. It was rather curious that the action of Newfoundland should almost synchronise with reports from Bathurst to the effect that the French were co-operating with us there for the restoration of law and order in Gambia. There was not wanting some suggestiveness in the manner in which some of the French newspapers awhile ago dealt with the alleged proposal that France should accept the concession of British Gambia as quittance in full of her claims in Newfoundland. No such proposal has ever been made, officially, at any rate; yet, reading between the lines, one would be disposed to think that it might not be unacceptable in all quarters across the Channel. The "French Shore" question in Newfoundland is as disagreeable in its possibilities to France as to us, and the advantages of the "French Shore" to France have always been grossly exaggerated, as perhaps French statesmen in their inmost hearts now acknowledge. The French people are not strong in geography, however, and are always predisposed to exalt their "rights."

In reality there is no such thing as a French shore in Newfoundland, but there is a long stretch of coast on which, by the Treaty of Versailles of 1785, French fishermen have the right to dry their fish, and to erect the stores, etc., necessary to their industry. It is a stretch of some 800 miles, from Cape John on the eastern coast to Cape Ray on the western, and the annoying thing to the colonists is that on this long stretch there are not one hundred Frenchmen resident. Probably not more than half-a-dozen French vessels visit the whole coast in any one year. Thus the striking thing about the so-called "French shore" is that it is not French at all in any practical sense. The whole value of the French fishing in the adjoining waters is quite trifling, yet on this shore the French, by treaty, claim the right to prevent the erection of any permanent buildings by the colonists within half-a-mile of the beach on which the few French fishermen dry their fish. Curiously enough, they found this claim not so much on the Treaty of Utrecht, as amended and confirmed by the Treaty of Versailles, as on a Declaration appended to the latter. That certain rights are established by treaty is not disputed, but the vexed question is as to the value and expediency of them.

For the purposes of the fisheries the treaty shore is practically of no value to France, and the only use to which it is put is for procuring bait for the fishery on

the Banks of Newfoundland. It is contended that the treaty does not give France the right to fish in Newfoundland waters for herring, which is the bait sought there; and it is objected that the bait caught in these British waters is used off the Banks for the catching of cod, which, being taken to the French island of St. Pierre, receives a large bounty by means of which it is exported to undersell the Newfoundland fishermen in European markets Latterly, however, the French have attributed more value to the assumed advantages of preserving a "nursery" for seamen for the French navy. This is a pure delusion in so far as the treaty shore is concerned. Whatever "nursery" there is, is on the open sea. the right to fish on which is not conferred or restricted by treaty, but which belongs to all nations. The treaty shore is at least a hundred miles from the fishing ground, where is the real "nursery." The tenacity with which the French cling to this delusion forms the real difficulty in effecting a settlement by compromise or exchange.

Now, apart from the strong feeling in the colony, both against the pretensions of France and at the alleged high-handed methods of British naval officers sent to preserve the peace and to watch operations under the *modus vivendi* (which is a sort of armed truce), there is a strong economic reason why we should hurry up a settlement of this vexed question. The industrial development of our oldest colony is prevented by this French nightmare. Practically nothing has yet been done to utilise the valuable iron ore deposits of the island, and it is becoming a necessity of the British Empire to obtain more supplies of this mineral to enable us to hold our own against the United States. The dabbling that has been going on for some years at Pilley's Island, Exploits Bay, is not worth talking about; but Newfoundland is capable of immense things in iron production. In Conception Bay is a considerable island which is practically one mass of ironstone of rich quality, ranking among the richest in the world. It is brown hematite, yielding, we believe, over 60 per cent. of metallic iron, and it lies so near the surface that it is obtained at the minimum of expense for extraction. There is no difficulty about working this ore, but there is considerable difficulty in developing the not less valuable deposits in the western portion of the island, the natural outlet of which is over the so-called French shore, from which the colonists are debarred.

The Steel Company of Nova Scotia have established at Cape Breton a steel plant which is regarded with much jealousy and apprehension by the steel makers of the United States. It is thought that Nova Scotia is destined to be the cheapest and largest producer of steel in the world, though, of course, it is only in its infancy yet. A plant of 400 coke ovens is being erected at the coal-mines at Sydney, C. B., and a number of blast-furnaces are in process of erection. For the feeding of these furnaces it is intended to bring the iron ore from Newfoundland. The Nova Scotia coal is, if not the cheapest, one of the cheapest coals in America, and there is plenty of limestone adjacent, but no ironstone. Some years ago the proprietors of the Sydney coal-mines acquired the largest of the ore-mines on Belle Isle, Newfoundland, where there are 30,000,000 tons in sight; and they then made terms with the municipality at Sydney, and with the Government at Ottawa, under which they merged the coal undertaking into the Steel Company, and capitalised the new concern at 20,000,000 dols. Belle Isle lies about 12 miles from St. John's, Newfoundland; it is six miles long by three miles broad, and it is barely 300 miles distant from Sydney, C.B. The ore there is as easily mined as any of that in the Lake Superior mines, so that, as compared with the steel plants in the United States, the Sydney plant has immense advantages in its comparative nearness to the ore beds and its close proximity to coal. Belle Isle is not more than a day's steaming, and the steel plant at Sydney is on the water front. All the ore for the Pennsylvania

furnaces, on the other hand, is brought down the lakes to ports in the neighbourhood of Cleveland. These ports are several days' steaming from the ports at the head of the lake where the ore is shipped, and after the ore is landed at Cleveland and Conneaut, it has to be carried inland by rail for distances varying from 150 to 200 miles.

In a recent address to the Canadian Manufacturers' Association of Toronto, Mr. Moxham, the general manager of the Sydney Company, enlarged on the enterprise. As a steel producing centre, he compared Sydney, C.B., with the Middlesbrough district of England, the Luxembourg district of Germany, and the Pittsburg district of the United States. At Pittsburg, he says, it costs 3·25 dols. to assemble the materials for a ton of iron, but at Sydney it costs only 79½ cents.

This is a very striking statement, and continuing the comparison between Pittsburg and Sydney, Mr. Moxham further said that the cost of getting a ton of iron or steel from the Pittsburg region to tide water is two dollars; while at Cape Breton iron and steel are made alongside the ocean wharves. As a result of the advantages which Sydney enjoys, Mr. Moxham declares that steel from there can be exported to Europe at 6 dols. a ton less than from Pittsburg, and he says that it is the expectation of the company that the bulk of its product will be sold in Europe. The duties on iron and steel now levied under the Dingley Tariff will, of course, be an obstacle in the way of the importation into the United States of any of the products of the Sydney plant, and the bounties which the Canadian Government pay on iron and steel will also furnish an additional obstacle, as under the Tariff law an extra duty equivalent to the bounty would have to be paid on any Canadian iron or steel brought into the States.

As the Sydney plant uses non-native ore, the bounty now received from the Dominion Treasury on the iron and steel produced is less than that paid in respect of iron and steel made from ores mined within the Dominion of Canada. When the Bounty Bill was before Parliament in 1889, Sir Charles Tupper desired to have the Newfoundland ores classed as Dominion products; but the Laurier Government would not put the Sydney enterprise on an equal footing with the plants already in existence in Canada, which are using exclusively Canadian ores. Until July, 1902, the bounty that the Sydney company will receive on pig-iron is 2 dols. a ton. From that date the bounty will decrease in amount until it disappears altogether. The Sydney company will soon have their 400 coke ovens in operation, all equipped for turning to the best commercial account the residual of the coking process. Steel mills on an extensive scale are also being laid down, and by midsummer Nova Scotian steel will be in the market.

It is certainly desirable for the success of this and other enterprises depending on the mineral resources of Newfoundland that that colony should enter the Canadian Confederation, from which it has hitherto stood aloof. But the Dominion will not take the island into its fold until it gets rid of the French incubus and the attendant dangerous and always imminent possibilities. Never, therefore, was there greater reason to make valiant efforts to come to terms with France.

It is said that France will not condescend to accept a cash payment for surrendering a treaty right and a sentiment. And it has been contended, on the other hand, that we ought not to buy up an abstract right by the gift or concession of concrete property in the form of territory. Well, but France has the two little islands of St. Pierre and Miquelon, just touching the coast of Newfoundland, which are simply the strongholds and shelters of gangs of professional smugglers from whom France derives little profit and no glory. Why not make an exchange of territory in Africa or elsewhere for these two little islands *plus* the whole of the French claims in Newfoundland? For the sake of the colony and the empire we can afford to give France even more than her abstract claims may be worth—claims which she cannot part with to anyone else but ourselves.

The Purchase of the Leyland Line Steamers.

THE purchase of a controlling interest in one of the two greatest lines of British merchant vessels by an American capitalist, to do with it, so to say, as best he likes, and the fact that not only the chief owner of the line, although a British subject, but also all the British shareholders in his company, should unanimously approve of this purchase, and are ready to sell their own shares to the foreign purchaser, notwithstanding that each and all of them must know that the ships they are placing under American control will be used against the interests of their own country, is a sign that should well make us pause and spend a few moments in reflection. From a strictly moral point of view, some persons will say, the part played in this transaction by our fellow-countrymen ought to be characterised as reprehensible in the highest degree. We must not be too hasty, however, in our verdict, and it will be well, therefore, before deciding, to follow Charles Reade's suggestion, *i.e.* to put ourselves in the place of those whom we are judging.

That former Governments of Great Britain, as well as the present one, have failed in their duty by not placing our merchants in a position to hold their own against outside competition, and by making it impossible for them to continue their business rather than to sell it to foreigners who alone can reap profit from it because they are not hampered by the restrictions placed upon British subjects, can hardly be denied. Mr. J. R. Ellerman, the chairman of the Leyland Line of steamers, the controlling interest of which was sold, as above said, to Mr. Pierpont Morgan, has brought a strong indictment against those at the head of affairs, in his contribution to our contemporary, the *Daily Mail*, on May 8th, in which he enumerated some of the absurd impediments placed in the way of British shipowners by the leaving in force of laws and regulations formulated at an era of commerce entirely different from that in which we are now living, some of them being drafted, in fact, at a period when steam navigation was unknown. Many persons, including Mr. Ellerman, declare that an entire revision of our fiscal policy is necessary if we are to hold our own against American competition. Be that as it may, and taking into consideration merely the case of the sale of the Leyland Line—for the fiscal problem deserves a fuller discussion than can be entered upon at the present moment—as long as the shareholders of the concern were honestly convinced that they would not be able under the existing conditions to obtain fair profits from their investment, and that these conditions are likely to continue, and might involve even serious losses to them in case others were to accept the offer made by American purchasers, we can hardly blame them for acting as they have done. If somebody is to blame, it must be those who compel a British merchant to resort to what cannot but be distasteful to him, in order to protect the legitimate interests of those that have the nearest claim upon him.

The purchase of the Leyland Line steamers may or may not benefit our competitors. One thing is certain, the readiness of the owners to sell is a clear symptom of something being not well in the body public, a warning that serious complications may arise unless prophylactic measures are taken. It is no argument to say that buying £10 at a premium of nearly 50 per cent., as the American purchaser does, is not business, especially as the shares are those of a company organised only last year, at a time when the shipping industry was in much greater favour than at present. Of course it is not business; it is gambling, pure and simple. What business man could afford to pay such a premium if he relied upon recouping himself by legitimate profits? A gambler is ready to pay any price, for, trusting to chance, if not to worse, he thinks he may get back any price, and honest calculation is useless to him. American business methods are, in the vast majority of cases, tainted with the element of chance; in many instances chance and brute force have equal shares in the transaction, and cases where chance and fraud are partners are not unknown.

But all this does not lessen the danger of the situation. Granted even that sooner or later those who use these methods come to grief—which, moreover, is by no means certain to occur, for in many cases a good deal remains unbalanced in a human life when death intervenes—granted that the biter ultimately will be bitten, that does not alter the fact that ere this consummation is achieved, if ever it is, he may have done an infinite amount of harm to honest persons. This being so, it is not wise to display indifference or to trust to the virtue of our own righteousness. If, according to the Biblical text, the harmlessness of the dove is not improperly mated with the wisdom of the serpent, our Government need not fear to be accused of diffidence if it should decide to add a little wariness to the power of its time-honoured fiscal policy.

Electric Traction and Electrolysis.

THE rapid extension of electric traction throughout the country has naturally caused the gas and water companies to take steps for the protection of their interests, by urging upon Parliamentary Committees to insert, in those Bills for traction schemes which affect their areas, a clause which shall make the traction authorities responsible for any electrolytic damage caused to gas and water pipes by the leakage of current from the traction systems. The question was raised on several Bills last year, and in the London County Council Bill the gas companies succeeded in obtaining the insertion of such a clause. As the number of Bills to be considered this year is greater than ever, both sides prepared themselves for a hard struggle; and, in the first round, as we may call it, on the discussion of the Sheffield Corporation Bill, a victory has just been declared for the gas companies. This decision seems to have caused great alarm among promoters of electric traction schemes, and the correspondence columns of some of our electrical contemporaries have been flooded with their remonstrances. Stated briefly, the arguments of the electricians are these: No case of electrolysis caused by leakage from a traction system has yet arisen in this country, and it is therefore wholly unnecessary for Parliament to legislate for its prevention. Further, the Board of Trade regulations are quite sufficient to meet the difficulty; and, lastly, if this liability is to be put on promoters of traction schemes, the public will not provide money for them, as they will refuse to subscribe to a concern which is weighted with an unknown liability. To take this last argument first, we do not believe that the insertion of such a clause as that complained of will at all affect the public subscription to electric traction schemes. It might, and probably would, have had a harmful effect in the days when electric traction was first introduced, for very little was known then about this means of locomotion. But to-day the circumstances are entirely changed. The public has experienced the superiority of electric tramways over the old horse tramways, and demands that this new form should be more widely introduced. Where there is a public demand for a thing, the money will always be forthcoming, even though much more onerous liabilities than this be imposed. But we can better appreciate whether this liability is really a hardship or not, when we consider the other two arguments. If electrolysis occurs, it must be the result of one of two things—either the Board of Trade regulations are sufficient, and have not been complied with; or they are insufficient. If the latter be the case, this new clause simply remedies the defect; and if the former, then all that the clause does is to impose a penalty for non-compliance with the regulations. Thus this argument of the sufficiency of the Board of Trade regulations defeats itself. But what shall we say of the first argument? To ask Parliament to defer legislation till a case occurs, is like telling a householder that he need not have a lock on his door until his house has been broken into. Everyone, including these writers with whom we are now dealing, knows perfectly well that electrolysis is

almost certain to occur unless great precautions are taken. It happens almost every day in America, where there are practically no regulations. The fact that no case has as yet arisen in this country, does not deny the possibility of electrolysis arising, but rather gives a testimonial to the watchfulness of the Board of Trade. If the same watchfulness be maintained in the future, we may reasonably expect the same immunity from electrolytic damage; why, then, need there be such alarm? Why should there be such agitation about being made liable to pay for a thing, which on their own showing is most unlikely to occur? It scarcely seems necessary to pursue the argument further. We desire, as much as anyone, to see electric traction very widely introduced throughout the country; but we cannot approve of its being allowed to prosper by doing a preventible wrong to other important industries; nor do we think that to allow such a thing would be to the real interests of electric traction.

Various writers in the electrical journals have gone out of their way to make a personal attack on two distinguished electricians for having given evidence on behalf of the gas companies, and thereby helping greatly to lead the Committee to its actual decision. The present President and a past President of the Institution of Electrical Engineers are accused of having played false to their profession, and of having used the official position which they hold or have held in the Institution in order to impress the Committee against the traction scheme, and the Institution is called upon to denounce these gentlemen for this action. We earnestly hope the Institution will do no such thing. The advancement of electrical engineering, which is the *raison d'être* of the Institution, is a very different thing from the advancement of the pecuniary interests of some of its members. The two learned professors whose action is complained of stated on oath their honest convictions on the question under discussion. If the gas companies were deprived of the assistance of electricians, who alone can speak with authority on such a subject, then only one side of the question could be put before the Committee, and the object of appointing such a Committee would be defeated. Science will never be advanced by a concealment of the truth, and for any person to seek to muzzle the mouth of another who does not agree with him, is to brand himself as a coward. We hope, therefore, that the Institution will not be so short-sighted as to allow itself to be made a tool for the benefit of a few gentlemen who have axes to grind.

The same question has been raised again more recently in the Bexhill Tramways Bill, and in this instance the Committee has decided against the gas and water companies. Thus at the present moment we have merely a repetition of last year's decisions—one on each side. This want of uniformity is very unsatisfactory. There would be a great saving of time and of money if Parliament would decide finally one way or the other and not leave it to each Committee to decide the point for itself. It is quite clear that until this is done, the subject will have to be thrashed out anew every time a traction scheme is promoted in a district containing gas and water pipes. This may suit the lawyers but it involves a heavy loss of money to both industries.

Commercial Prospects in South Africa.

THE unfortunate conflict in South Africa has continued far beyond the period of time that, in the worst case, was supposed to be necessary for the completion of the war, and even at present few would venture to assert that peace is in sight. One thing, however, is absolutely certain —namely that the unconditional establishment of British supremacy is a *sine quâ non* condition of ultimate peace; and, this being so, the magnificent natural resources of the country will sooner or later attract commercial men from all parts of the civilised globe. All of them will partake of the profits to be derived from the development of a country, which, though British, will, as far as commerce and financial investments are concerned,

be equally accessible to all comers, owing to the unparalleled liberality of British rule and British institutions. Whether we do not pay occasionally somewhat dearly for the maintenance of the principles of freedom is a problem that has been forced upon our attention in recent years somewhat unpleasantly, but the discussion of which we will postpone to some other occasion. A question of more immediate interest is, whether our manufacturers and importers will be ready, whenever the time is ripe, to enter at a moment's notice upon their duty of securing for the Mother Country those commercial advantages that they cannot fail to secure if they bring to the notice of intending buyers the solid and careful workmanship of British goods, and the honesty and straightforwardness of British business methods. But however firm the British exporter's conviction may be that he is easily first as regards the quality of his goods, compared with foreign products, yet, amidst the strenuous activity of the times, to be first in the field is half the battle, and secures advantages that enable even mediocrity to compete successfully with the highest merit, if the rival is absent at the critical moment. That the Germans are conscious of this truth—or, we should rather say, truism—is proved by the fact that as early as last summer one of their best-known commercial publications, *Kuhlow's German Trade Review and Exporter*, published at Berlin, took care to point out to its readers in a special article, written with great thoroughness, the most successful trade methods in South Africa and the conditions that have to be taken into account by firms intending to obtain a footing. So appropriate is the article to which we refer, that we cannot give better advice to our own exporters than to read it, in full, and we regret that space does not permit us to quote it *in extenso*. They will find there that railways permit commercial travellers in South Africa to travel first-class on a second-class ticket; they will see stated the cost of annual licences in Cape Colony, in Natal, and in British Bechuanaland. There is further mentioned that a liberal expenditure is absolutely necessary to obtain a footing in trade, and reference is made to the existence of the South African Commercial Travellers' Association. The giving of credit to small inland firms by some travellers, owing to the keenness of competition, is described as a somewhat risky venture. The best route for visiting the various towns of importance is outlined, and the expenses are estimated as from £2 10*s.* to £3 daily along the lines of railway, and at a comparatively high figure during visits to the interior. The importance of taking along a complete assortment of samples is shown, and advice is given to establish, as the Americans do, sample depôts where the goods can be displayed to the best advantage, and machinery may be shown in motion. Money invested in this way is said to more than justify the rather heavy expenditure required for this purpose. Attractive and well-printed advertising matter is mentioned as a necessary adjunct of other inducements given to the prospective purchaser. Packing, we learn, should be done strictly in the manner desired by the purchaser, who is the best judge of what is required. The time and labour expended for this purpose, says the author, can be charged, of course, in the price made for the articles ordered. If an importer requests that bottles of acid should be packed in carbonate of lime, it will not do to pack them in shavings. Strong boxes about 40 or 50 ins. square, says the writer, should be used for shipment, and under no circumstances should boxes be employed that are too large for the goods contained in them; empty spaces, he emphatically declares, must be carefully avoided. Though the terms on which business is done vary in South Africa, as elsewhere, credit from three to six months is the rule, we are informed, when dealing with firms of good reputation. All these, and other details, are given in the article alluded to, and though they may seem trifling in character, they are a clear evidence of the fact that Germans, in their enterprise, leave nothing to chance, and minuteness in preparing their plans of campaign has more than once secured them signal victories where brilliant dash alone would have utterly

failed. Americans have been equally wary and busy, as appears from their Consular Reports, in preparing for action as soon as peace permits the opening of a regular commercial campaign in South Africa; and even during the present armed conflict, they have not been remiss, as our readers know, in securing whatever was to be secured. That among their tactics will be the dumping of surplus stock at impossible prices upon the South African market, in order to keep home prices at their present level, can hardly be doubted. All this ought to be taken carefully into consideration by our exporters, and we hope that they will earnestly ask themselves whether they are ready to be in their places when the commercial campaign begins. If so, we repeat, all devices of their foreign rivals will not prevent them from securing a fair share of the profits; for the quality of their goods goes a good way towards obtaining success, and the patriotic spirit that the campaign has aroused in all our British possessions will, no doubt, give additional aid to our own manufacturers in placing their goods. Procrastination, however, or a stubborn refusal to make concessions to local idiosyncrasies would be fatal, and to jeopardise our position by handing over more of the world's markets to our rivals, without an effort on our own part, might not unjustly be stigmatised as criminal.

Thames Traffic.

ALTHOUGH the action of the London County Council is not invariably worthy of approval, yet it must be granted, and we cheerfully make the admission, that many of the aspirations of the body deserve the highest possible praise. This remark applies especially to recent efforts made for the purpose of establishing an efficient municipal service of steamboats on the river Thames. At a remote period of the past century we believe the steamboat service was considered to be reasonably satisfactory, and it was perhaps tolerably suited to the then existing requirements of the metropolis. With the flight of time the spirit of the times has changed, but very little alteration has appeared desirable to those responsible for the conduct of passenger traffic on the great metropolitan highway. There is probably no part of London so redolent of the past as that between and adjacent to the banks of the Thames. Those who are acquainted with river life know how little it represents the bustling and feverish activity of the present day, and how strongly it recalls the easy-going and leisurely habits of the past. Perhaps it is for this reason that the managers of the various abortive attempts to perpetuate passenger traffic have clung so desperately to the obsolete methods of earlier days. The boats themselves were designed and controlled in the most nautical manner. They were decked fore and aft, and on the after deck, presumably considered as the place of honour, smoking was not permitted—passengers indulging in this pernicious habit being severely relegated to the fore-deck. It never seems to have occurred to the responsible officials that the products of combustion from many pipes, mingled with the warm oleaginous breath of the engine-room, might prove unwelcome to the more fastidious occupants of the after-deck. No shelter was provided from the rays of the sun, nor from occasional showers of rain, beyond two hopelessly mouldy cabins, more to be dreaded than any adverse climatic influences. At the best of times the service of boats was irregular and apt to cease entirely on the least provocation. Long intervals were apt to occur between one boat and another; uncertainty always existed as to the probable duration of any given journey, and gradually the feeling became predominant that the river boats did not constitute a sufficiently reliable and expeditious means of transit for busy people. Under such circumstances, it is not surprising that successive steamboat companies have not been successful. The Thames Conservancy does nor appear to be wholly free from blame, for that body has always exacted heavy tolls for the use of antiquated and inadequate pier accommodation, and has consistently declined either

to build new piers, or to permit steamboat companies to do so. That there should have been faults on both sides is only natural, but London is less concerned with the apportionment of blame than with prospects of improvement in the future. It would evidently be useless for enterprising individuals to place upon the river a new line of properly equipped vessels, unless suitably constructed and reasonably accessible landing-places were provided. On the other hand, it would be a waste of energy for the Conservancy to modernise landing arrangements in the absence of modern steamboats. With the laudable object of removing existing difficulties, the Rivers Committee of the London County Council proposed that Parliamentary powers should be obtained to enable the Council to take over the piers, and to establish efficient steamboat services upon the entire length of the Thames within the County of London. This scheme is at the present moment in abeyance, but we hope it may ultimately be brought to a satisfactory issue.

The value of a municipal service is largely to be derived from the circumstance that not only can the proper kind of boats be provided, but the land communications also can be organised and controlled in an appropriate manner. Steamers are now obliged to use such piers as exist, and to depend almost entirely upon chance customers. On the other hand, a service under the auspices of a municipality would have the benefit of landing-stages in convenient and prominent positions, so that the boats might be readily accessible to pedestrians, and might also be fed by various railway, tramway, and omnibus systems. If established upon such a basis, the steamboat service should prove of great convenience to the large riverside population, which already contributes an annual traffic of some 200 million passengers to the streets of London. In order, however, that the scheme might be fully developed, the service must be rapid, punctual, and continuous throughout the year. It would then take a recognised position amongst other permanent locomotive facilities of the metropolis, most of which, and especially suburban railways, appear to be incapable of coping satisfactorily with the increasing demands of the public.

The development of so promising a highway as the Thames is a matter of almost Imperial interest, and if it be the fact that a large section of the public is impatiently waiting to make use of an efficient transport service, there can be no reason why the institution should not be self-supporting, after the manner of kindred undertakings.

British Coal.

At various times since the application of the steam engine on a large scale to industrial purposes, questions have been raised as to the probable duration of British coal-fields as sources of supply. More than thirty years ago the fear was expressed that, if the rate of increase then exhibited were maintained, our coal supply would become exhausted during the next hundred years. Although it is now well known that such views were due to over-estimation of consumption and under-estimation of available supply, there can be no doubt but that the matter was very properly made the subject of investigation. For three centuries before the year 1800 the average coal production had not been more than about 2·8 million tons per annum; for the first half of the last century the average production was about 40,000,000 tons per annum; for the next ten years 1851 to 1860 it averaged 60,000,000 tons a year; and for the following five years 1861 to 1865 the yearly average was 90,000,000 tons. In the face of figures so striking as these, no one can wonder if views of a somewhat alarmist nature were entertained. Such opinions were materially modified by the Report of a Royal Commission appointed in 1866 to inquire into the whole subject. This report was issued in the year 1871, and it is still regarded as affording the most reliable basis for computations with regard to the practical duration of the coal-fields of Great Britain. We do not mean to say that the calculations as to consumption presented by the Commission

have stood the test of experience; for, as will presently be seen, they were almost as much below the mark, as alarmist calculations were above it. But the computation made of the available amount of coal has never been seriously questioned. Referring to the year 1870, the Commissioners estimated the quantity of coal within the limit of 4,000 ft., contained in seams of not less than one foot thick, and after due allowances for waste and unavoidable loss, to be ·90,206,000,000 tons, and further they estimated the amount lying beneath the Permian and other strata at 56,248,000,000 tons. Thus the grand total was assumed to be 146,454,000,000 tons in 1870. During the remaining years of the past century, this total has been diminished by the aggregate output of 5,025,000,000 tons, so that the National storehouse now contains 85,181,000,000 tons within the 4,000-ft. limit, plus 56,248,000,000 tons at a lower level, or a total of 141,429,000,000 tons. The questions affecting the entire population of the United Kingdom, and the industrial portion of the population in particular, are, How long will this stock last? and at what period of its depletion will the yearly production become so diminished as to interfere with the convenience of ordinary consumers and with the progressive expansion of trade? These are questions that are by no means easy to answer, although valuable light is thrown upon them by the statistics available at the present time. Alarmist calculations of the past have generally been made upon the basis of a geometric rate of increase in consumption. Such a mode of computation is now known to give unduly large figures. The Royal Commission of 1866 based calculations very largely upon the ascertained decrease in the average decennial rate of increase of population, and the export of coal was assumed to remain as a constant quantity of 12,000,000 tons per annum. Neither of these theories has been substantiated by subsequent facts, for the home consumption of coal has increased during the last thirty years by 80 per cent., whilst the population has only increased by 31 per cent., and the export of coal has increased by about 290 per cent. Thus, while the consumption for 1900 was estimated by the Commissioners at 173,000,000 tons, the actual consumption proved to be about 230,000,000 tons. Including the reserve lying beneath the Permian and other formations, the Royal Commission believed 360 years to be the limit of duration of British coal-fields; but in the face of the figures stated above it is quite evident that the estimate was unduly optimistic. Since 1870 our coal production has been more than doubled, and if a similar process should take place within the present century the stock lying within the 4,000-ft. limit would be entirely exhausted by the end of the present epoch. Whether so great a rate of increase will take place depends very much upon the condition of the export coal trade, which now accounts for more than 58,000,000 tons a year. Adding a reasonable proportion to the estimated figures of the Royal Commission, it is tolerably certain that our coal-fields may be expected to hold out for at least two centuries, and that the question of complete exhaustion is one that need not enter into the counsels of the present generation. For the time being, the only troubles of the coal user are high prices and insufficiency of supply, but neither of these appears to be due so much to scarcity of the material itself as to the deliberate policy of those concerned in the coal-winning industry. There has been talk of restricting the export of coal with the object of avoiding injury to home manufacturers, but we doubt whether such a measure would be of the least use. Mine owners and colliers would simply continue to keep up prices and to restrict the output by artificial means as heretofore. So far as the trade of the Kingdom is concerned, much more is to be feared from the short-sighted action of owners associations and trades unions than from any immediate diminution of mineral in the home coal-fields. Education will do nothing to remove these hindrances to prosperity, for education does not change the nature of any man. Competition from abroad seems to be the only argument that can be expected to produce any material improvement.

"We are, in the vastness of our possessions, losing our grip on national sentiment. It is our duty to maintain intact, and to defend by sea and land, all that our empire builders have left us. The day that sees the defence of the British Empire sapped, sees the disintegration of the Nation's trade and the hands of civilisation's timepiece put back 200 years."—Rt. Hon. Lord Charles Beresford, C.B.

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Our Candid Rival in the Far East . . .

Referring to Russia's recent efforts to obtain the lion's share of the export trade to Persia the *Sviet* publishes an article, from which we quote the following significant passages:—"We have frequently pointed out the necessity of including the Persian Gulf, and in general all Persia and Western Beluchistan, within the sphere of Russian influence. Should any complications arise between ourselves and our rivals in the Persian markets which might lead to hostilities, we have nothing to fear. We are sufficiently ready for them. But, even in such an event, the stronger our influence in Persia, the greater are our chances of success, *i.e.*, of paralysing the rule of England in Afghanistan, Beluchistan, and Persia, and that of Germany in Asia Minor." Frankness, at all events, is a virtue which makes up for many of the minor vices; only it is somewhat superfluous in the present case, as there are few among us who are not able to see that the keynote of Russian political as well as commercial activity has been for many years the desire to wrest as much territory in Asia as possible from England's influence; while Germany is too well informed by her representatives abroad to have any illusions regarding her Eastern neighbour's sentiments, and need not be reminded that Russia is ever ready to get all she can; for which reason German statesmen do not solely trust the "traditional friendship" between the two countries, but keep on the alert to bring into operation, if necessary, the *lex talionis*. Meanwhile, Russia's frankly acknowledged intentions will be kept in check for some time, at all events, by the somewhat embarrassed state of her exchequer; and this fact permits us to look without much emotion upon the commercial campaign inaugurated at the beginning of the year in Persia. Instead of being annoyed by it, we would be grateful to the Czar's ministers if our own government could be induced to follow their example, as regards the principle of their scheme, which is neither more or less than state-aid to the country's shipping interests. Others of our rivals have anticipated Russia in the use of this effective means for obtaining commercial success; and, though for the moment there is not much danger, in the end our aloofness may cost us dearly; for Russia's financial condition will undergo considerable alteration, once that her natural resources begin to be developed in a rational manner. February 14, was the date fixed for the departure, from Odessa, of the first Russian vessel of a new line of steamers organised by the Russian Trade and Navigation Company for the purpose of trading with Bagdad, Bushire, Bandar Abbas, and other ports on the Persian Gulf, and to open up a direct and regular commercial communication with Southern Persia. The pioneer vessel was loaded with 485 tons of Russian products, notably sugar and kerosine, while representatives of several leading Moscow firms were to go out on her to

direct personally the first moves of the campaign. The government aid alluded to consisted in fixing special freight rates at very low figures for merchandise shipped through directly to Odessa for shipment by the new line, and these rates were granted for exports from all the chief commercial centres of the Czar's dominion. Though it was first granted to the new shipping company, exactly the same privilege will be shared by all other subsidised or private steamship companies on the Black Sea, both for goods shipped to the Persian Gulf and to other Eastern ports, as, for instance, Port Arthur and Vladivostock on the Pacific. It is stated that the arrangement is at present of an experimental character merely and limited, therefore, to one year. We have little doubt, however, that it will be renewed at once at the expiration of the term, as it is sure to pay amply for the cost incurred in its inauguration.

Armoured Concrete Construction . . .

THOSE of our readers who are familiar with the Continent may have observed how much more largely Portland cement concrete is used there than in the United Kingdom. This feature is especially noticeable in France and in Germany, where remarkable results have followed the introduction of iron or steel bars into the material when used for structural purposes. This form of construction was not particularly successful as exemplified in some of the buildings and other structures at the Paris Exhibition, but it is almost certain that the failures experienced there were entirely due to faulty design and not to any unsuitability of the material itself. Considerable difficulty has no doubt been felt in the past with regard to calculations as to the strength of the combination, but recent tests have furnished data which it is believed are entirely reliable. Structures of armoured concrete can be rapidly erected, they are naturally fireproof, permanent, and require no paint except, of course, for decorative purposes. One of the best known patents applying to the form of material mentioned is about to be exploited in this country by the representatives of a German firm, who have for many years been engaged in the execution of Government and public works in Germany, Austria and Hungary. We therefore direct the attention of our readers to this further proof of the indefatigable energy of our Continental rivals. It may well be that the process will offer attractions to those who find difficulty in obtaining prompt delivery of steel joists and girders. Of course, steel girder construction is naturally a slow operation, requiring a considerable amount of labour, not to mention the fact that a proportion of the section is wasted in consequence of perforation for riveting. In armoured concrete the tensile portions are formed of steel bars, and the concrete not only binds these together, but also forms the compressive portion. It is claimed that a girder in armoured concrete can be made and fixed in position before a steel girder could be half made. Some large warehouses in Germany, having seven or eight floors, and including armoured concrete girders and columns, were erected by the patentees in five months, and it is estimated that more than a year would have been occupied in the erection of steel framework.

A Record in British Shipbuilding . . .

ALTHOUGH the purchase of the Leyland Line by an American capitalist should not be taken lightly by us and should be a warning to us of the seriousness of foreign competition, it happens at a period when we might justly feel proud of the development of our merchant-marine in recent years, for it is the first time during its existence that, as the recently published statistics of Lloyd's show, the tonnage of the vessels of the British Empire exceeds fifteen million tons—a noble record for the new century. The data published a year ago showed that its growth had attained the aggregate of 14,700,000 tons, and since that time the register of the United Kingdom alone has received an addition of 286,478 tons,

while the tonnage contributed by the colonies raises the total to the high-water mark above mentioned. More satisfactory yet is the fact that in this aggregate no appreciable percentage of obsolete vessels is included, and that of this enormous fleet sailing under British colours the bulk consists of steamers, which contribute 12,000,000 tons to the total. Nearly 600,000 tons of our old ships were transferred by our ship owners, by sale, to the merchant fleets of other nations, and their place was taken by new ships of modern style and equipment built by our shipbuilders, who, notwithstanding the heavy work done for our own shipowners, were able to add also 382,475 tons of new vessels to the fleets of their foreign customers. Of these the Germans alone took 107,483 tons. That the most recent additions to our merchant fleet were of a high type is best shown in Lloyd's statistics which demonstrate that, notwithstanding the increase of the merchant fleet of the United Kingdom in tonnage by 286,478 tons, the total number of its vessels on the register decreased in 1900 by 210, which, of course, means an increase in the average size of the vessels, which in fact was 2,058 tons; a notable addition to the average size, even if only the last five years are taken into consideration. This growth and improvement in our merchant marine make up to some extent at least for the disappointing events of the last few weeks, and inspire us with the hope that we may yet recover the ground lost through them.

The President of the Institution of Mechanical Engineers on Engineering Education . . .

THE well-worn question of the most suitable method of training young men for an engineering career formed the subject of Mr. W. H. Maw's presidential address last month. The system to which he confines his attention is the one most usual at the present time, consisting of the three stages—school, technical college, engineering workshops—taken in the order named. In common with all whose experience entitles them to express an opinion on the subject, the President is dissatisfied with the training given in the average public school, but we most strongly dissent from his advocacy of earlier specialisation as a remedy for the admitted defects of the work in our schools. Even if it were the case that boys showed their aptitude for engineering or other special careers early in their school life, and if it were possible to subdivide them into sections and to give to each section a course intended to fit the lads in it for their intended career, the effect could only be a more luxuriant growth of the soul-destroying system most appropriately known as "cramming." The work of the schoolmaster should be to develop a boy's intelligence, to teach him to observe and to reason, and not merely to load his memory with as many book statements as he can be induced to assimilate. How much he knows, and even what he knows when he leaves school is a very secondary matter. The great thing is that he shall know it intelligently. He will then be in a position to learn when he enters the technical college, and to continue to do so when he goes to the shops. With regard to the technical colleges, Mr. Maw makes a novel but, we fear, a not very practicable suggestion, viz., that the colleges should be specialised in their more advanced departments, and that after passing through the earlier stages at any one of them a lad should finish his course at one where his future work is made a speciality, such as, for example—to quote Mr. Maw's own words —"the construction of ordnance, of textile or milling machinery, or even of machine tools, such as used in advanced practice." Such a scheme would be difficult to carry out, even with the aid of an unlimited number of benevolent millionaires; without this it would be out of the question. Mr. Maw's mind has evidently been dwelling on the difficulty experienced by pupils of acquiring information when they get into the workshops. It is true that in the shops they no longer have instructors to provide information already digested for them. But if this could be,

would it be advisable? They cannot be kept in leading strings all their lives; and if lads have not acquired the power of learning for themselves at the end of their technical college course, we fear that the continuation of the leading-string system would only prolong the agony, and that it would be much better for them to abandon all hope of ever becoming engineers, and betake themselves to callings which make smaller demands on the intelligence.

Board of Trade Electric Lighting Regulations . . .

THE decision of the Board of Trade has now been given on the application of the Westminster Electric Supply Corporation for an amendment of its electric lighting regulations, the inquiry into which was considered in our editorial columns last month. It follows the lines which we foreshadowed, and provides that when the consumer withholds his consent to a change in voltage "after the undertakers have offered to comply with the general terms and conditions imposed by the local authority (in London the County Council), and, if not required to do so under these terms and conditions, also to pay the reasonable cost of or incidental to the change (including compensation for any loss or damage incurred in consequence of the change), the undertakers may appeal to the Board of Trade, and that Board may, if they think fit, give their consent to the change on such terms and conditions as they impose, and the consent of the Board so given shall, for the purpose of this regulation, have the same effect as the consent of the consumer." The decision is a satisfactory one, though we think the Board might have gone a step further and laid the onus of making an application to them on the refractory consumer.

Electric Boats . . .

THE problem of transforming horse-trams and steam railways into electric lines is occupying at present the attention of the British public so much that it will come as a surprise to many to learn that electrically-propelled river and pleasure boats have already ceased to be a novelty with us, and that electric motive power in many cases possesses considerable advantages over steam for propelling most of the smaller vessels. This fact has been very lucidly demonstrated recently in an article by Mr. E. W. Ehnert in the *Elektrotechnischer Anzeiger*, in which he compares the respective merits of the two forms of propulsion, and shows the distinct advantages of electricity for special purposes. Cleanliness and decreased vibration are in themselves strong points in favour of using electric energy, but what in time will definitely decide the choice as far as pilot boats and harbour-police boats, for instance, are concerned, is the fact that for all boats that are in constant demand the annual cost where electricity is used is considerably less than where steam furnishes the propelling power. Boats that must be in readiness at a moment's notice, if steam is used in them, have to keep steam up, whether moving or at rest, and consequently waste a great amount of fuel. If electricity is used the current can be shut off and restarted at any moment, so that there is no waste of energy and fuel while the boat is at rest. The best method of using electric energy in boats under the present conditions appears to be the employment of accumulators; and, as Mr. Ehnert points out, experience seems to show that the old-fashioned Planté type accumulators are preferable, notwithstanding their greater weight and cost, to those with paste plates. There are, no doubt, many other cases in which electrically-driven boats will supersede those propelled by steam, and the increase of their number will lead to the increase of charging stations on the banks of rivers and lake-shores, thus extending the limited radius within which electric boats at present can be used. This adds another reason to the many which should induce British manufacturers to secure at least a reasonable share of the profits that during the present century will be derived from electrical engineering.

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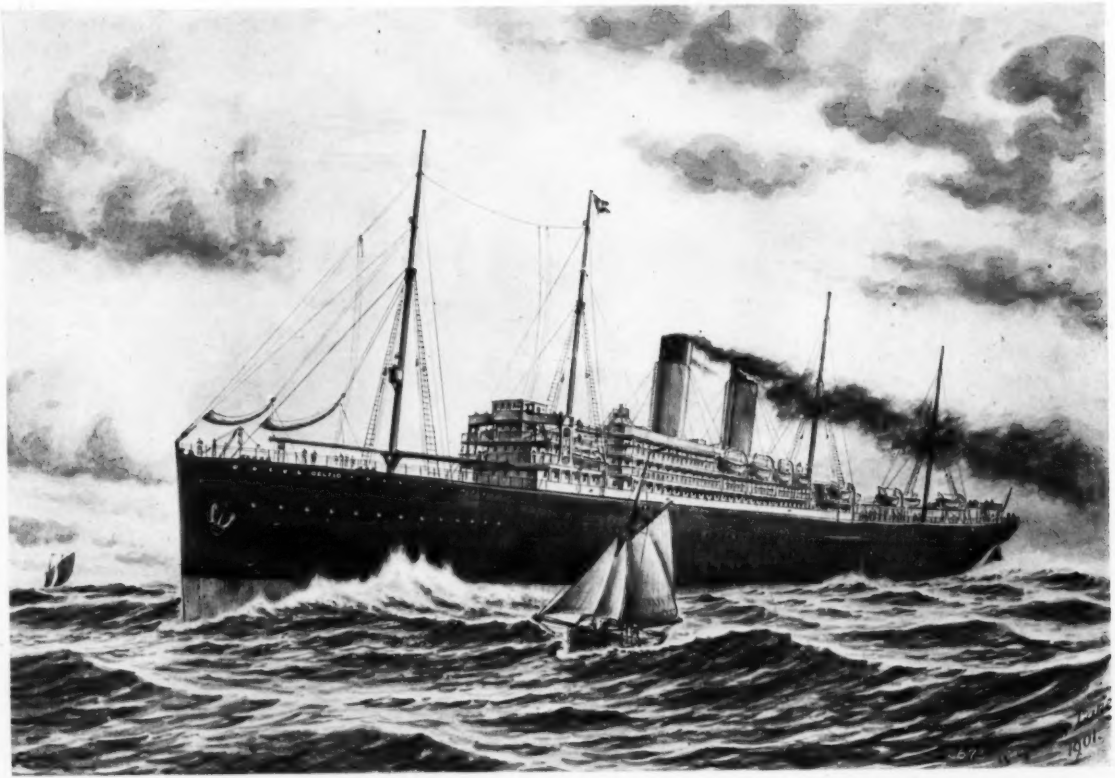
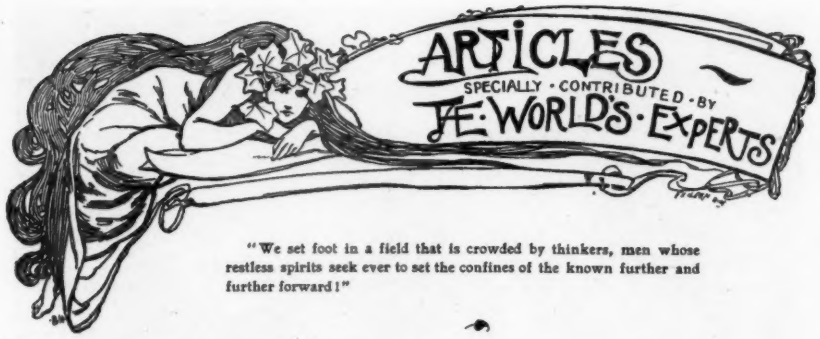


THE WHITE STAR LINER "CELTIC."
CONSTRUCTED BY MESSRS. HARLAND AND WOLFF, BELFAST.



"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

The Automatic Transmission of Material.

By ARCHIBALD J. S. B. LITTLE

MR. LITTLE is a native of Dumbarton, and a son of Mr. Gilbert Little, founder, chairman, and managing director of the New Conveyor Company.

Mr. Little started in 1890 at the London offices of this Company, afterwards entering the service of Messrs. Harpers, Ltd., of Aberdeen.

During the past six years he has been associated with many installation of labour-saving and transporting appliances in this country, and is thus in a position to speak with authority upon the subject of the automatic transportation of materials. The Stockton Tramways Power Station, the City and South London Railway Co.'s Power Station, the Lanarkshire Steel Works gas producer and boiler plants, the United Alkali Co.'s 80-ton per hour phosphate plant, the Edinburgh Electric-Power Station coal and ash plant, Brunner, Mond & Co.'s soda plant, and many other important undertakings have at one time or another engaged Mr. Little's attention.

The son of a literary man, Mr. Little early in life began to write for the technical press, and when only 17 years of age entered into a discussion in the *Daily News* on the subject of the antagonism of workmen to labour-saving devices.

IN the "Aid Book to Engineering Enterprise," Ewing Matheson states: "Facility of transport is an important incident in most manufactures, not only for the raw materials but for the finished products, and an industry otherwise feasible and desirable may, for want of such facilities, be entirely hindered." This want being felt, several engineering firms started an adjunct to their existing business to meet the requirements of those manufacturers desiring to mechanically move matter; but in time the product of the transport appliance makers was encouraged to the extent of necessitating the specialising of this line of machinery.

Men are never sufficiently careful and select in the exercise of a new power, consequently mistakes arose which, while

FIG. 1.—JOGGLED STEEL-PLATE BELT CONVEYOR, FOR TRANSPORTING GRITTY AND LARGE MATERIALS.

not stopping the advance in adoption of the new power disposer, still hindered that universal application of the same which is so much to be desired. With the surmounting of the existing obstacles and rectifying of avoidable mistakes, the specialists achieved and endeavoured to perfect their experience by careful study, coupled with irresistible resolution and industry. Therefore, there now exist companies who can manufacture machinery to convey or haul any article from a pin to a freight car, showing a saving in cost which is so appreciated by the applicants that the amount saved is in most cases (speaking from my experience in this country) carefully kept secret.

An unlimited possibility of improvement has revealed itself in the increased adoption of this class of machinery, in the matter of economy resulting to the capitalist, and in the alleviation to the lot of the labourer. Users of conveyors and elevators must incline with Professor Marshall to the belief that every displacement of labour by machinery brings about an elevation in the quality of labour—that is, will increase the proportion of labour in employments which try the muscle less and are less monotonous. Thus machinery will take the place of the workers engaged in arduous tasks, while free and compulsory education will tend to develop their minds, and prepare them for duties requiring intellectual rather than muscular exertion.

The problem of handling materials consists in elevating or conveying them, either in their preparation, storage between the mines or manufactory and the market, storage at retail yards, or handling at points of consumption. In each case the solution depends on the distances over which they have to be transferred, the

rate of handling to be attained, the size and nature of material to be dealt with, and the length of service required.

In many trades the principle of handling materials in bulk prevails in preference to continuous manipulation of small quantities; and, although in some cases the former method is found more acceptable and advantageous, it is axiomatic to say the latter system is the more efficient by reason of the work being spread over a longer period, thus by one of the first principles of mechanics reducing the size of machinery required to develop power for operating. In shifting material in trucks with capacity of, say, 1 ton each on an elevated track, it is necessary to provide structure to support this load combined with the extra weight of truck and also of engine if one be used; therefore a large capital expenditure is incurred.

One of the most promising situations for the installation of conveyors and elevators twenty years ago was a gas works. The task of preparing gas for distribution embraces the process of distillation, exhausting, scrubbing, purifying, measuring, and storing. In the first case we are confronted with the problem of handling the coal which we will say is now lying in the canal wharf or railway siding awaiting unloading and storing. If in a barge the coal could be grabbed out by a power shovel, swung round and dumped into a pit, from which it would gravitate through screen or crusher to elevator boot, where it would be picked up by the buckets, which are generally 18 ins. wide, to handle 30 tons an hour. If the coal is small an elevator could be used instead of power shovel by swinging it on a jib pivoted on structure and designed to lift it in and out of barge or ship by steel carrying ropes or chains suspended on pulleys attached to structure on wharf; an ordinary bucket elevator would do this duty, with telescopic shoots at top to allow for altered height of top dumping point as the elevator is lowered when barge is being emptied, or to suit the tides on a river. For dealing with

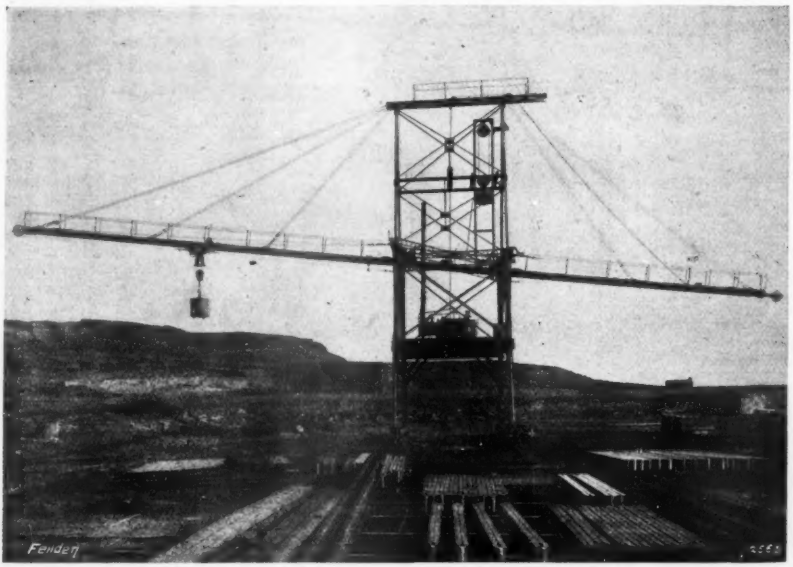


FIG. 2.—TRAVELLING TOWER TRANSPORTER, FOR MATERIALS IN BULK.

mixed coal varying from small to pieces of 15-in. surface a 24-in. wide tray elevator would be required, formed of continuous overlapping steel plates fitted with concave lifting plates. Coal is now elevated by stationary elevator about 30 ft. to be pitched over sprocket wheels at top into a shoot leading to a horizontal conveyor. The elevator should be cased in, otherwise the dust will blow about. In an installation I once had to do with, situated near Boulter's Lock on the Thames, the smudge fairly rained round a large hotel on the opposite side of the river which was frequented by gentlemen attired in flannels and starched linen, accompanied by their female friends in usual brilliant latest Parisian or Bond Street Spring fashions. Well, the complaints lodged with the local authorities led to the removal of open type elevator, which was subsequently substituted by a close cased one, after which no trouble was experienced. Another reason for having close casing is that it prevents from falling on people working underneath lumps of coal which might drop from buckets.

The conveyor can be any length, especially if electric power for driving is at hand; failing which, we have to fall back on gas or steam. Say then this conveyor is 300 ft. long, 200 ft. of which is inside the coal store. The standard designs will span 45 ft., so with one intermediate support, and the structure carrying elevator forming another, the carrying gear outside is provided for, and a free passage left for carts or trucks. Just inside the coal-store and underneath the main conveyor there is usually put a cross conveyor which can take coal directed off the former and carry it to a third conveyor, placed in juxta-

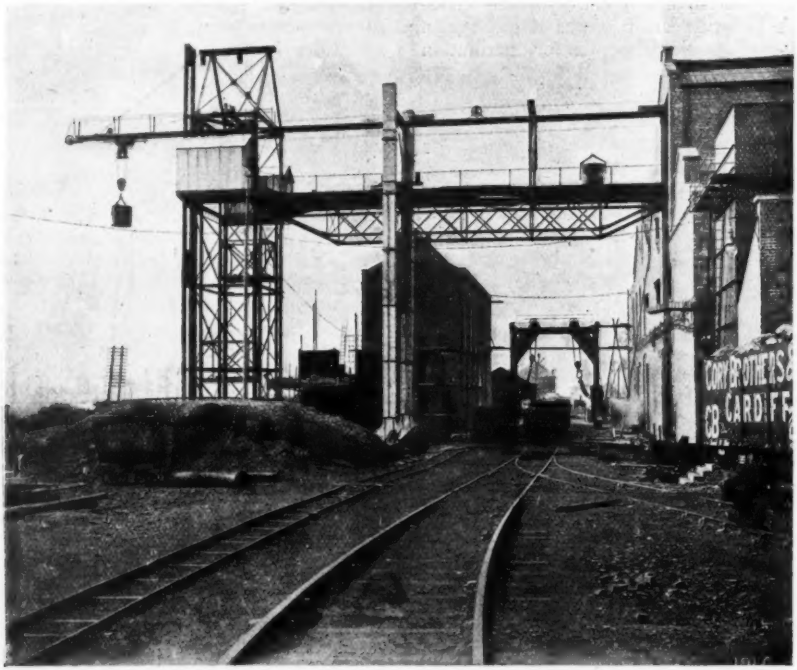


FIG. 3.—COAL WHARF FITTED WITH TRAVELLING TOWER TRANSPORTER.

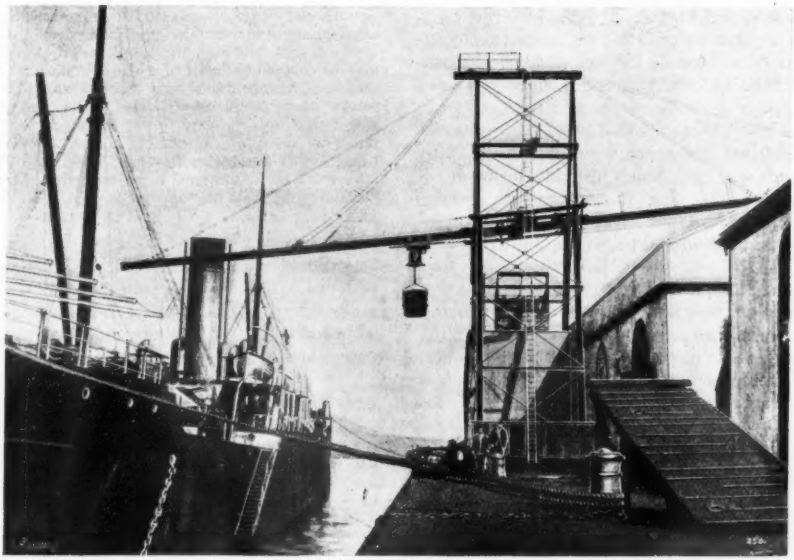


FIG. 4.—TRAVELLING TOWER TRANSPORTER, WITH JIB MODIFIED TO SUIT STEAMERS.

position to the first one. This, with a store 200 ft. by 50 ft., would give an automatic distributing plant to put from six to seven thousand tons of coal in store in twenty days of ten hours each day, at a cost of handling not exceeding $\frac{1}{2}d.$ per ton, against $3d.$ by hand, which is exclusive of man's wages filling grab or elevator in barge. These figures are actual cost shown by a plant now in use with ten years' work to its credit; they include cost of upkeep and depreciation. The cost of upkeep worked out at $\frac{1}{2}$ per cent. on original outlay, so the engineer in charge was not much troubled with breakdowns and repairs. The former system was by rope lift and tipping trucks, so there would be a greater comparative saving where no power system was at work. In taking from barge it is usual to weigh the coal, and this can be done by dropping contents of power grab into a weigh hopper situated over second elevator pit.

To deal with the continual drain from store to retorts, conveyors can be put in culverts to draw off coal and locate it to another elevator to be lifted to distributing conveyors, which are fixed over coal tanks large enough to hold 24 hours' supply for the retorts. In a new or reconstructed works these retorts would, of course, be set on the inclined principle at an angle of 32 degs. to horizontal, and would take a charge of $7\frac{1}{2}$ cwts. every six hours. They are fed from overhead hoppers through subtruded measuring chambers having a variable capacity of from 5 cwts. to 8 cwts. for a 20-ft. retort. By hauling over a lever the top door shuts off the supply from tanks, and the lower one opens and supplies contents of chamber through a travelling shoot direct to retort, down which coal slides in an even charge. (No shovelling or "tickling" is wanted to get coke out of retorts.) When coal is carbonised the lower door of retort is opened, the iron "stop" removed, and out slides the coke into a slaking conveyor, delivering over end into a tray elevator, which dumps

on to a plate conveyor generally run over canal and extended 100 ft. so that coke can be screened, loaded to barges, carts, coal trucks, and surplus dropped on coke heap.

There is no doubt that the above-described system of overhead tanks, with measuring chambers to each row of retorts, is the best so far devised, having many advantages over the large single-hopper system and travelling loaded charging-shoot. It is incomprehensible that there are not less than two large installations on the latter plan even now being put up, because it is almost like employing a steam hammer to crack a nut. When adopting conveyors, surely it is only logical to carry out the complete idea and not dump coal into a large tank fixed at one end of bench, requiring manual labour to take the charged travelling shoot from end of house to retort, especially in a case alluded to by the manager of Edinburgh Gas Works, in which he described the manual process of dragging this shoot along as entailing more labour than it requires to manipulate the charging machine used on horizontal retorts. The theory has been advanced by a manager of works in Denmark that by adopting the one large tank the weight of structure to carry the continuous tank is avoided; but, considering that if the one tank has a capacity equal to the continuous one, the same weight has to be carried at the end of bench instead of being distributed all along same, it is difficult to follow this reasoning, especially bearing in mind that the buckstays on bench are strong enough when lengthened to bear the weight of the long tank.

It is difficult to give cost of handling per ton, as the systems must of necessity vary at different works, but at works where I have helped to install these plants the managers proved big reductions. Mr. Herring, of Edinburgh, late Huddersfield, in reply to my request, wrote :—

"In reply to your particular query, the cost per ton is not an exact criterion, the condition of labour varying in different localities. For this reason I have always preferred to speak of the relative saving as compared with hand labour in one and the same works, the duration of physical exertion on the part of the operators being the same, or rather because of necessity where mechanical appliances are manipulated the physical exertion is much less, although the same period of time may be covered in performing the operations. On this basis the operations of getting the coal to the retorts, charging the retorts, drawing the coke and wheeling it into the yard, firing the furnaces and removing the clinker; in short, the whole operations of carbonising cost 2*s.* 11*d.* per ton by hand labour. Exactly the same work by means of coal elevators and conveyors and inclined retorts costs 1*s.* 4*d.*"

Mr. Herring speaks from a long practical experience with the system, and is conversant with most of the installations erected in England and on the Continent. This plant did not include automatic coke conveyors.

Mr. Bromley, of Batley, Yorkshire, reported as follows :—

"Hand charging 2*s.* 3*d.* per ton, which includes coke and coal wheelers; inclined system 1*s.* 4*d.* per ton, and includes elevator men and coke wheelers. Foremen's wages are not included in these costs, but are the same in both cases."

Another letter, from Mr. Brown, Engineer and Manager of the Cambridge Gas Works, was in these words :—

"In reply to yours *re* our elevating and conveying plant, with inclined retorts, I am pleased to inform you that this system has reduced our cost of labour per ton of coal carbonised from 2*s.* 10*d.* to 1*s.* 3*d.*"

A very commendable reply from a North-country engineer, one of the ablest men in the profession, is next given :—

"The saving effected at these works in carbonising expenses since the introduction of inclined retorts and coke handling machinery has been about 10*d.* per ton on the coal carbonised, being now 1*s.* 8*d.* against 2*s.* 6*d.* under the old régime."

This arrangement includes coke conveyors for the outside of retort house only.

When you are putting in conveyors either for hot or quenched coke, be careful and select, shunning any scraping or pushplate pattern. The coke must be carried or the wear will be very excessive both on bottom of trough, chains, and scrapers.

A German pattern of coke conveyor has been put on the market with a great boom, but, to my thinking, the principle is wrong, as the idea is to have two light steel chains with cross bars at intervals of about two feet, the whole arrangement being designed to scrape the coke along

in sliding along a shallow steel trough. It was found that the bottom of trough quickly wore out owing to the action of the moving coke grinding it away, so a false bottom was made, with the introduction of an additional plate; but this now gives trouble by buckling owing to heat.

Theory suggests that, if the work was so severe on the steel plate, the grinding on the more easily separated granular material being transported must have been concurrently deleterious, and practice proves the point. The propelling bars are not close down on to bottom of trough, consequently the pointed shaped coke tends to allow it to jamb in the space, thus causing excessive friction, resulting, besides in loss of power, in the coke being ultimately broken. The chains and wearing parts are made very light, and equal strength for a conveyor 30 or 300 feet long, to cheapen cost of renewals, but at the expense of more frequent stoppages for repairs. The chain quickly wears itself and the angle irons on which it slides out, and the cross bars are continually bending. Result is a poor worrying transporter, inefficient for wear and deleterious to the product being transported, which can only be conveyed with an excessive expenditure of power.

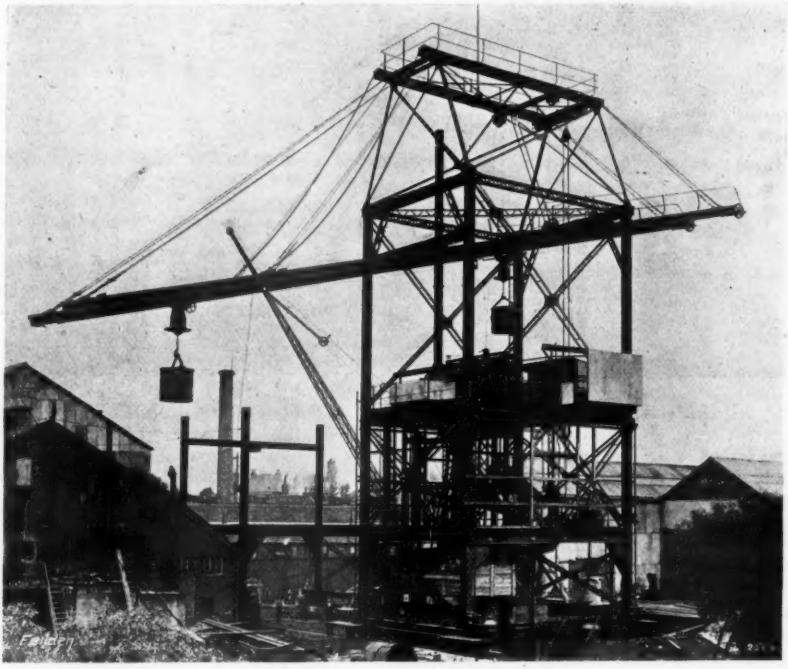


FIG. 5.—TRAVELLING TOWER TRANSPORTER, SPECIALLY BUILT FOR DEALING WITH PHOSPHATES.

It naturally occurs to even non-users of coke or ash transporters that the only economical method of moving these residuals is by carrying them on a steel travelling belt, thus reducing wear on

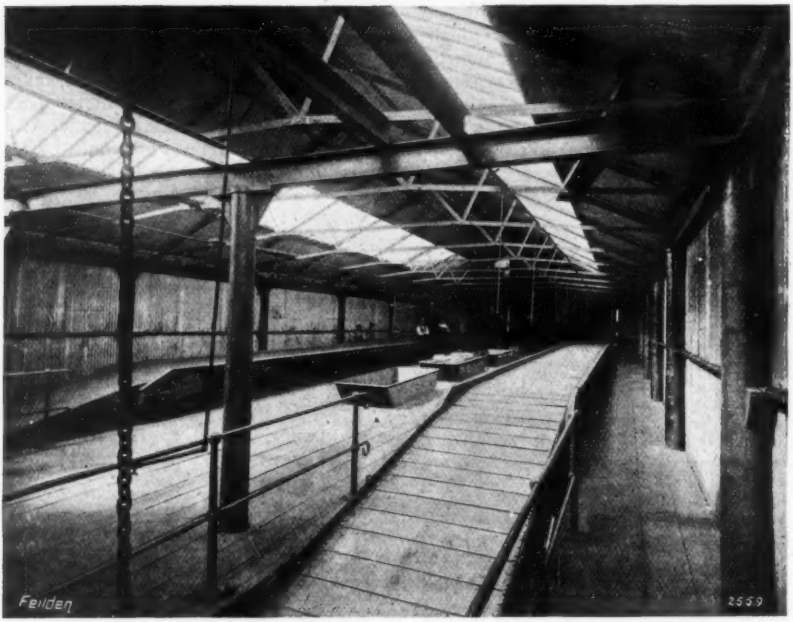


FIG. 6.—TRAVELLING TABLES, FOR TRANSPORTING COAL FROM SCREENS TO RAILWAY TRUCKS.

machinery, breaking of coke, and loss of power, provided, of course, the plates are mounted on a strong chain carried on rollers, and submerged in water to prevent buckling due to heat.

I admit the first attempt to adopt this form of conveyor was unsuccessful, but fault lay in the details, principally the bad design of chain and through the same, together with plates and coke being conveyed, forming in their travel a primitive pump, which drew all the water in trough over the end, but in later installations; especially the latest at Blackburn Gas Works, these salient faults have been eliminated or reduced to an extent that does not allow of their being considered faults. It is estimated that the introduction of similar machinery at Tottenham will effect a saving in cost of handling coke about £7 per day, handling about 80 tons. Several trials were made to take away coke from ovens at the collieries of W. Baird & Co., in Glasgow, but the latest conveying device erected on a special tray plate pattern is really the first one they have got to stand the excessive strain put upon it, and Mr. Forgie must be congratulated on his success.

Reverting to coal conveyors, I should like to add, in parenthesis, that it is really peculiar to learn the attitude of the assuming American to scraper or pushplate conveyors, and let it be understood that my diatribe against this form of transporter is only levelled at its adoption to handle gritty, bearing-searching materials. Chatting with an electrical engineer, who assumingly learnt all that was possible about coal conveyors before he left the States, I chanced to remark that "So-and-So, the consulting engineer, had accepted pushplate conveyors for his very complete fit-up for a certain power station." "Oh! he ought to know better," interpolates the infallible one. I said nothing,

but on my return I looked up some files containing correspondence on the matter. A writer in Canada, in asking for particulars of a 50-ton per hour scraper conveyor, mentioned it was to replace a fit-up supplied from the States, which he described as a screeching scraper, that was anything but a "howling success." It was so designed without any skidder supports that the scrapers, made in the shape of a flattened V, slid along on the bottom and sides of trough, which were made to correspond. It would not do the required quantity, and was to be put on the scrap heap at first available opportunity. Reference to American catalogues shows that this is the object principally known out there as the scraper conveyor, so the "reverence" with which it is regarded can be understood but not sympathised with. All scraper conveyors are good, and when properly designed with rigid lattice steel framework, there is not a more efficient transport appliance that can be adopted in its proper place.

Another letter from a friend of mine in the States reached me on his return there after a tour through this country with me inspecting some, and not the latest or best installations of labour-saving machinery :—

"I am sorry to say that Americans are not very kindly disposed to inclines, and have quoted as an example a plant which has just been completed for the Brooklyn Gas Company. I visited the plant last week, and it is no wonder that inclines have no prestige when such examples of them are foisted on the gas engineer, who expects to reduce his costs ; they have more men than with the ordinary hand stoking, and their conveying apparatus is a farce."

Do, then, reject all offers for conveyors on a rickety design, especially if they provide for the use of detachable chains.

Practical hot coke conveyors have not been working long enough to enable figures to be quoted showing saving effected, but there are many plants consisting of the outside elevator and storing conveyors which have proved their utility. Mr. Hack, of Birmingham, says at least 7½*d.* per ton of coke handled is saved to the Birmingham Corporation by his plant, after taking all repairs into account ; and Mr. Duxbury, of Middleton, Lancs., has, we believe, secured even better results. The saving, however, in corporation work at least, is not the all-important point, as the introduction of coke transmitters is advocated on the ground of lightening the men's work and reducing the number of hands required, the latter being an important point in the winter season, when it is so difficult to get sufficient steady men to perform this hard labour. With the complete system for taking coke right from retort mouth to hopper, barge or cart, wagon or storage yard, one shilling a ton may be reckoned as the lowest amount of reduction over former methods.

Since the foregoing was written, I have been engaged for a week working one of the most complete retort houses in the country, which was put up to the designs of Mr. S. R. Ogden, the Corporation Gas Engineer at Blackburn. The retort bench consists of 10 beds of inclined retorts D-shaped tapered section 24 ins. by 15 ins. by 20 ft. long each, and eight retorts in a bed, provision being made in existing house for duplicating this plant. Coal is brought into store at end of house by railway trucks on an overhead line about 20 ft. above level of floor, being previously weighed on one of Avery's 40-ton machines, which weighs the empty truck on its return. The coal is dropped direct into a 15-ton Hopper, the top of which corresponds to the level of floor, and from there it gravitates to crusher at a rate which is regulated by design and speed of crusher, and by a sliding door worked from ground level, the latter only being used when very small coal is exclusively handled. As the editor of one of our technical papers once observed to me, "Tell people about your failures, it will interest them, and they can follow out the means you adopted for overcoming them." Well, it looked at the first start off as if the plant was not going to work so regularly and automatically as we guaranteed it should. To explain this thoroughly necessitates first a description of the plant. The coal then, be it understood, after being crushed, was

raised in a 24-in. bucket elevator at the rate of 40 tons per hour, and deposited over top sprockets down an inclined shoot into a double chain scraper conveyor, situated over charging end of inclined retorts, and having intervening coal hoppers, with measuring chambers attached. These measuring chambers are provided with an inlet and outlet door worked by one operation which ensures one being open and the other shut. In the bottom of chamber and above outlet door are placed two sliding doors which can be set in several positions to decrease the size of outlet. Each measuring chamber is placed to feed a vertical row of three retorts, and the operation of charging is as follows:—Insert coal stop in bottom of retort and close the bottom mouthpiece lid; then draw over the retort to be charged a travelling conducting shoot, the mouth of which is rolled into top opening in retort. In this position it is under the measuring chamber, which, on having its doors worked, discharges contents down shoot into retort which automatically receives coal along its whole length to a depth of approximately six inches, the success of the installation depending on the coal laying in retort in an even thickness. On starting to work this installation it was found that by closing the patent check plates in the lower end of measuring chamber to get proper speed for coal to leave same, and effect even charge, that a lump of coal, say, 5 ins. by 4 ins. would jamb across the opening and prevent the contents from leaving the chamber. The plates were consequently removed, and this resulted in the coal dropping out of chamber too quickly, as the conducting travelling shoot was choked by the first rush of coal, causing part of the coal to remain stationary in the shoot, and as coal is very small on a whole, consisting of nearly all dust and very few lumps, it was not lively enough in dropping from the decreased height to get up speed sufficient to reach the lower end of retort. The rolling mouth then had to be drawn out of retort, and the remainder of charge which was still in shoot dropped on the floor.

When the retorts were drawn, it was discovered that the first rush of coal had reached the bottom, where it lay about six inches thick, tapering back two feet to approximately three inches, and then that thickness continued about six feet, after which it increased gradually to nearly ten inches for the remaining twelve feet. In drawing out the coke, the thick part at bottom broke away, but it was most difficult to get the light charge six feet long to come out, as it was fixed on to the thick part at top, which, of course, jambed in the retort. The men on the charging stage had to poke the coke and break it up before it could be got out. On one occasion I was standing on the top stage watching this operation and it seemed the coke would never come out, when it occurred to me that the bottom lid must have been left closed as there was no rush of sparks up the retort as there would have been with door open. This, it turned out, was the fact; while the men on the bottom were endeavouring to extract coke from one retort, the man on top stage was assaulting that in the next retort which had not been opened.

When the coal crusher had been taken down, and rolls altered to reduce coal to one and a half inches cube or less, we were enabled to put check feed doors back in measuring chamber, and this cured the whole difficulty.

Good heavy even charges were automatically achieved, and the resultant coke in one well-burnt-off adhesive mass slid out of the retorts in a body, breaking up as it left the retort. This coke drops directly on to an over-lapping plate conveyor, which traverses trough and is submerged in water, which keeps plates cool and partly quenches coke, thorough slacking taking place at end where a spray is fixed. A continuous bucket elevator lifts coke from end of slaking conveyor, and feeds it on to the storing conveyors in the coke yard.

From the retort house we pass on to the purifier house, where the lime or oxide has to be lifted to and removed from boxes, which can be best and most economically done by transport machinery.

In a large house with say 20 boxes,

should advocate elevator and band conveyor with throw-off carriage and flexible shoots, or several elevators situated in various parts of the building to lift material and dump into boxes.

For a small house put in an elevator feeding pushplate or scraper conveyor made with steel trough and pushers; but do not have a scraper conveyor for wet, sticky, setting material over 30 ft. centres, or trouble will occur.

The difficulty experienced in describing examples of successful installations of conveying machinery lies in the infinite number and variety of such plants, which are to be found in nearly every kind of shop and warehouse, dealing with almost all classes of materials and substances, including bottles and bolts, coal and cocoa, sugar and sand, starch and cornflour, olives and fish, tin cans and boxes, tobacco and tea, phosphates and pulp, ice and hot coke, guano and clay, gold quartz and rags, nails and pins, newspapers and salt, and, in fact, nearly every known article used in all industries.

The question of economically handling coal from store to boilers is one which is commendable, and therefore two arrangements are epitomised; the first a small plant to feed six boilers, same having been erected in 1889, and in the words of the users, Messrs. P. & P. Campbell, Dye Works, Perth, it has been, and is still working to their complete satisfaction. The carts bring the coal and tip same into a hopper in floor, under which is situated the elevator boot, where the coal gravitates, and is lifted by buckets to the spiral conveyor, which delivers to right and left into cross conveyors, fixed over and depositing the coal to stoker hoppers. This plant cost about £240, to put into position and replace parts in 11 years reached the value of £4. Of course, some repairs were done on the spot, but I am assured the same were very light.

A spiral conveyor is an excellent device

FIG. 7.—VIEW OF HOT COKE CONVEYING PLANT IN USE AT A LONDON GAS WORKS.

for handling small materials in quantities not exceeding 45 tons an hour, but when lumps to be moved are over 2 in. cube or the spiral is over 20 in. diameter there is a deal of risk incurred. As there is always a liability of foreign and large substances being included in the coal or other material to be conveyed, it is well to have grids to prevent same getting into the machinery, as an occurrence like this would buckle the spiral bar and cause a stoppage of two or three hours with the conveyor.

It is difficult for the inexperienced to understand how the spiral bar will convey more than the archimedian pattern, but of this fact there can be doubt, as was proved by lengthening one of the latter 20 ft. by adding necessary amount of former, so that the capacity was maintained and a further light load put into the new portion without damage to conveyor.

The second is a more modern plant to feed nine boilers at the power station of the City & South London Electric Railway Company. The coal is lifted by an elevator from pit at road level and dumped into overhead push-plate conveyor, which distributes it by means of breeches-shoots into coal bunkers situated on floor over boilers, between which a line of rails is placed. A 2 cwt. self-discharging truck can receive the varieties of coal which are stored in the bunkers,

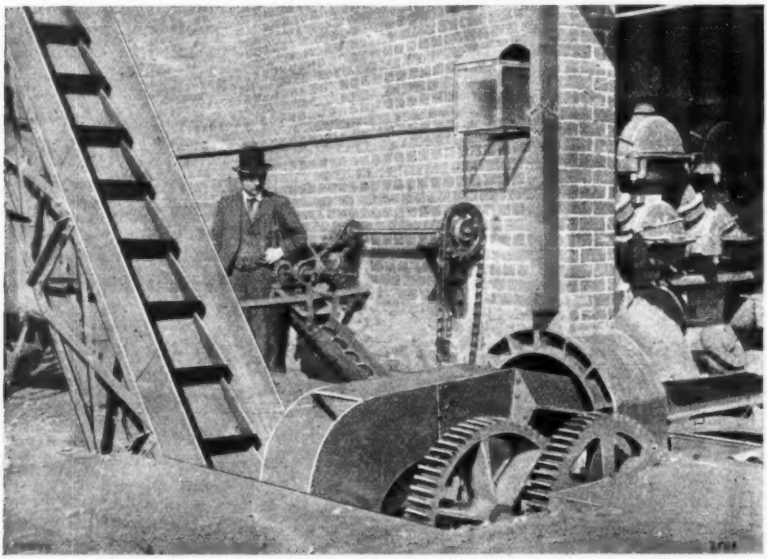


FIG. 8.—"SMETHWICK" PATENT HOT COKE CONVEYOR DELIVERING TO ELEVATOR.

mix same and travel to the hoppers in floor, to which are connected measuring chambers fitted with indicators to check the amount of coal used on each boiler up to 500 fillings. This arrangement accurately shows the efficiency of each furnace, and the plant is being extended to the five new boilers required for the Islington extension.

A new patent was introduced into this plant with success. A difficulty experienced with elevators was the inability of dumping, say, ten tons of coal into the

hopper with any hope of its being easily picked up by the buckets. These buckets take on an average about ten pounds of coal each, and each bucket in ploughing through a heap would experience a strain which it and the chains were not, as a rule, made to stand. Therefore an automatic feeder was designed to take the weight of coal and in revolving made to feed just sufficient material to charge each bucket. For Durham or similar soft coal a sliding door working on same angle as elevator can be fitted on boot and worked by eccentric with concomitant levers to lift and alternately force same down through coal to open and shut opening and thus feed without overloading; amount of travel could be regulated by altering throw of eccentric. This device is not serviceable for hard coal, because a lump coming between door and bottom of opening would injure the working gear, which it does not do with soft coal. A similar idea, but embodying shaking shoot to feed coke, instead of roller or slide as for coal, has turned out a great success. It feeds from a load of 20 tons of coke regularly to elevator boot.

The engineer to the company has also introduced an ash plant in which the tipping trucks carrying ashes are run alongside an elevator boot and tipped into same, the ashes then being lifted into tank having hoppered bottom. Carts are brought under tank and a lever is pulled which actuates sliding door, and this being opened the ashes are fed into carts.

In considering the question of stoking conveyors, most engineers consider they are debarred from utilising those having no mechanical stokers. Although a battery of boilers fitted with automatic stokers lends itself to the introduction of conveyors, it does not follow that their adoption is not beneficial where boilers are hand-fired. The Deepfields Company, at Bilston, Staffordshire, introduced in 1898 a conveyor to carry screenings from a rotary screen some fifty feet to front of three boilers. This small coal is shovelled on to grate in usual way. The plant fulfils the purpose for which it was supplied, and the engineer informed me it has as yet not cost a penny in repairs.

Many similar arrangements are at work, especially in Lancashire.

While dealing with coal handling plants, reference may be made to an installation of conveyors erected in 1896 to feed twenty-two rivet heating furnaces at the works of James Miller & Co., Coatbridge. These furnaces heat the bars for forty rivet-making machines of an automatic type. The coal from railway wagons is fed into elevators at a fixed price of $2\frac{1}{2}d.$ per ton, and the forty furnaces are worked by three men, whose wages are 25s. per week each, the conveyors being attended to by the man who oils and looks after the forty rivet-making machines. The first cost of this plant was about £700, including erection, and £10 a year will cover for all repairs and upkeep.

In a plant for storing coal at Jersey the coal is shot from carts into crusher over elevator and then lifted into two longitudinal pushplate conveyors, which discharge into store. The engineer and manager wrote to me stating that one great benefit obtained from this arrangement is expedition, and that it allows them to use steamers instead of sailing vessels for bringing over the coal. They formerly, by a truck arrangement, discharged at most 100 tons a day, the cost of trimming in store averaging $2\frac{1}{2}d.$ per ton; now they handle 300 tons a day at an average cost of $\frac{1}{2}d.$ a ton. The plant was introduced in 1893, and the wear and tear, according to Mr. Morris, has been very little, as, after dealing with 70,000 tons of large coal, the repairs have not exceeded £20, that is about $2\frac{1}{2}$ per cent. on outlay, not for one year, but for the five years. This plant is going to be taken down and re-erected in a new twin coal-store, where it will share the work of a new plant supplied for the neighbouring store.

In 1889, a coal plant was put in at the Kensal Green Gas Works, consisting of scraper and tray conveyors and bucket elevators. Nothing was heard of the plant till this year, when a wire was received asking for a new top wheel to be sent for elevator. This is the only order yet received for a replace part, and it appears that the plant has worked most successfully without the makers ever

FIG. 9.—CROSS ELEVATOR FOR COKE, DELIVERING TO BARGE.

hearing about it, although other manufacturers of similar machinery have been referred to it by users as an example of an unsatisfactory installation.

In electric power stations, the consulting engineers, who are mostly Americans, have "gone nap" on the gravity bucket conveyor-elevator, and for dealing with a large quantity of coal in a short time—as with the plant at Metropolitan Street Railway of New York—there is no doubt that this conveyor has proved a trustworthy and desirable transporter in respect of noiseless and smooth working. But when these 200 tons an hour coal-conveyors have the duty placed on them of clearing ashes away on the return journey, then it is doubtful if the result is all that could be desired. For instance, on the new plant at Glasgow the total length of conveyors will be about 800 ft. each, and we think it is an indubitable fact that to dump such a gritty residual as ashes on to an expensive conveyor of this pattern is an undesirable method, more especially considering that, for a boiler-house only about 220 ft. long, a length of conveyor of 800 ft. is being put to this objectionable use, because the return length of conveyor has to go back in roof of the house over coal pockets.

Again, with the combined system, to drive ash plant, you have also to provide power to run the empty coal portion, and, in addition, there is the difference in power required to drive a separate ash plant with capacity of say five tons an hour, and for driving the ash-coal plant which has a capacity of 200 tons an hour. As with wet ashes, it is not improbable that some will cling to the buckets, it follows that there is a chance of dirtying the coal when same is fed into a messy bucket. Another point is that, on this style of conveyor, having double chains fitted with rollers to carry same, the required amount of power to haul these travelling rollers is obviated when a conveyor with stationary carrying rollers is used. Perhaps the worst point about the gravity bucket conveyor, however, is the initial cost and subsequent upkeep account. In the New York Station there is a separate bucket conveyor for the ashes, but this delivers into the bottom strand of coal conveyor at the point where same leaves the building to cross the yard to canal, where it is located to barges.

At steel works, an old idea was to use small elevators and spiral or screw conveyors to lift and deliver coal to gas-producer mouths; but, with the introduction of such colossal plants as at the Lanarkshire Steel Co., in Scotland, where there are hundreds of gas-producers in four or five parallel rows, the small "one-horse" plant has been lost sight of, and engineers are now adopting hydraulic truck-tipping machinery and

automatic transmission plants on a stupendous scale, the operating of which might be succinctly summarised as follows: Coal trucks come in on the railway siding, being made with patent sliding bottom so that, by screwing open the same, mixed coal is fed into a 20-ton hopper, under which is fixed, in such a position that it forms part of the bottom of hopper, a 3-ft. wide slow-running plate belt or tray conveyor, which, in working, draws off a run of coal and feeds same over or through a screen (dependent upon size) to the elevator boot, the small going direct and the large through a two-roll breaker. With ordinary railway trucks, as used at the Lanarkshire Steel Co., it is advisable to apply hydraulic or screw rams made to swivel in lifting the truck by the back axle, the front wheels serving as the tipple shaft, and the coal is consequently made to slide out at end into the aforementioned hopper. An alternative plan is to install a rotary tipple, as used in collieries for upsetting tubs, the appliance consisting of two or more rings about 18 ft. diameter, braced together with angle and channel irons which are provided with rails to carry the railway truck. This truck being run into position, a clutch is thrown into gear, the tipple revolves and dumps coal out of wagons into hopper.

From breaker or screen the coal is gravitated to elevator boot, which cannot be overloaded owing to capacity of automatic feeder belt under hopper, and the 36-in. buckets elevate the fuel to a height of about 30 ft., where they pitch into a main conveyor traversing laterally across the parallel rows of gas producers. Over each row is a conveyor (or, of course, two if the elevator is in the centre with producers on right and left hand), which delivers into a separate measuring chamber holding a supply over bell-mouth on each producer, these being so fixed at the side of opening that "tickling" or probing of coal in the producers, which is sometimes requisite, is not hindered. Thus, with the exception of the upsetting of railway truck and opening of doors in measuring chambers, the task of getting coal from wagons

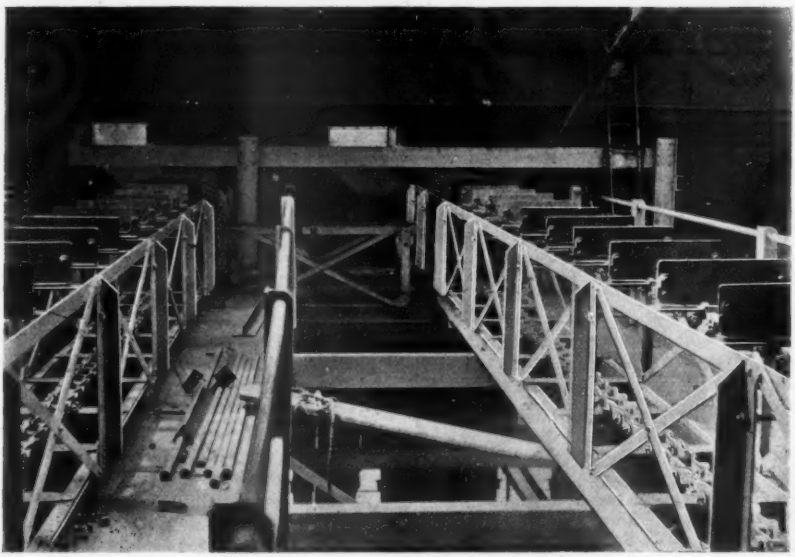


FIG. 10.—CROSS CONVEYORS FOR COAL FITTED ON ROOF OF BUILDING 73 FEET HIGH.

into the producers calls for no labour excepting the man to look after motors and oil machinery, which operation, if regularly and conscientiously performed, calls for a minimum amount of time and expense.

The illustrations which accompany this article have been most carefully selected by the editor out of a very large number taken, procured or purchased by the writer from places all over the world, and

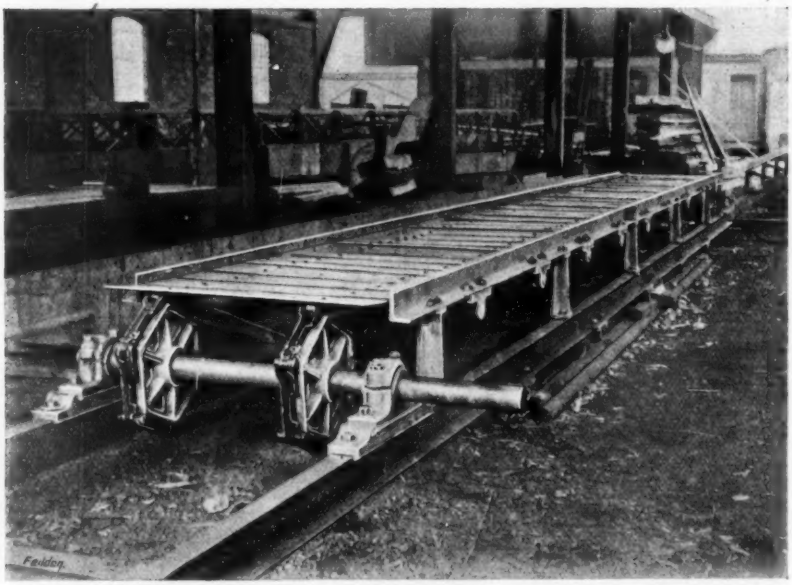


FIG. 11.—DOUBLE-CHAIN PICKING CONVEYOR, USED TO TRANSPORT CEMENT.

the intention is to make them tell a collateral tale to supplement the text, consequently they are not referred to in detail like usual illustrations.

No. 1 shows a 30-in. wide joggled steel-plate belt conveyor, used for transporting gritty and large materials, the one photographed being erected in a large stores on the Manchester Ship Canal. Grabs lift the phosphate rock out of ships and dump same through a grating having 9-in. sq. apertures, which directs material to elevator boat, from which it is lifted by 36-in. wide buckets, fixed on double strands of endless chains, and pitched over top sprockets on to cross conveyor, which locates material on to two longitudinal conveyors at right and left, and these conveyors (one of which is shown on photo) are 621 ft. long, arranged to deliver from the altitude at which they are fixed all over the stores. The conveyor shown delivers also over end on to an obliquely fixed conveyor about 300 ft. long. The whole plant was designed and guaranteed to lift 60 tons per hour, but very often a capacity of 85 tons is reached and maintained over a considerable period. Over 85,000 tons have been raised, and the repairs have been very small and uncostly. Each section of plant is separately driven by electric motors.

Illustration No. 2 shows a travelling tower transporter for discharging materials in bulk at rate of 50 tons per hour. These

towers are exceedingly useful for unloading boats, and are sure to effect economy on large coal wharves, especially if automatic weighers and conveyor transporters are used to fill and subsequently empty coal stores.

No. 3 gives a good idea of such a coal wharf, while No. 4 shows more clearly the application of the jib to suit steamer, the arm on water-side being made to hinge

London gas works. The elevator shown receives coke from a cross conveyor that is fed by two longitudinal conveyors, one on each side of the through-benches of horizontal retorts. The coke is drawn from retorts by a machine and dropped directly on to conveyor, which consists of steel joggled plates attached to 12-in. pitch chain fitted with rollers and traversing the watertight steel trough, the plates

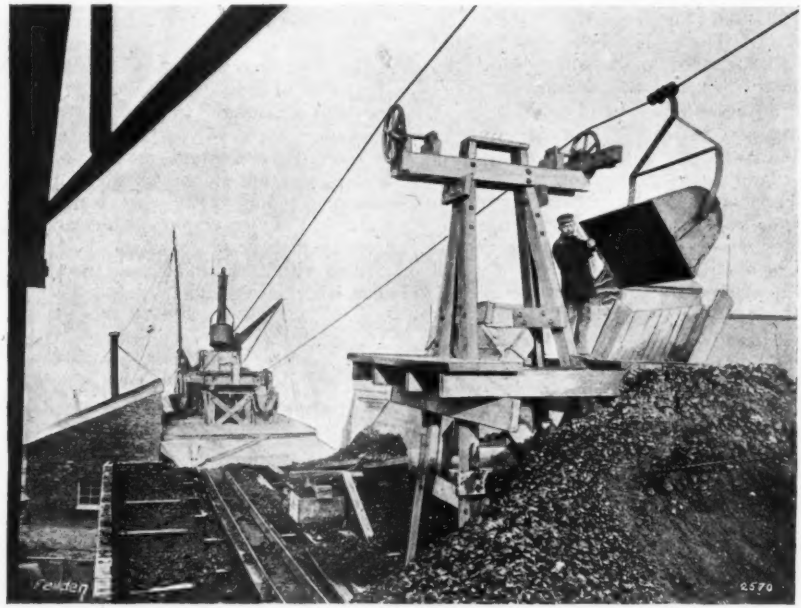


FIG. 12.—FORM OF TRANSPORTER FOR CONVEYING QUANTITIES OF MATERIALS OVER UNEVEN GROUND FOR LONG DISTANCES.

up. No. 5 shows a similar but larger transporter, which was supplied for handling phosphates.

The two travelling tables shown on illustration No. 6 receive coal from screens and carry same to railway trucks, the end being hinged so as to allow it to lower into truck, thus reducing fall of coal and obviating breakage.

Photo 7 shows the outside section of a hot coke conveying plant erected in

being just submerged to prevent buckling through heat from coke. Quenching of coke is done at the end of these two conveyors before delivery is made to cross conveyor. The elevator supplies cross conveyor fixed on top of storage hoppers, and delivery is made to carts, as shown, or over end into hopper feeding railway trucks.

The next picture shows end of a "Smethwick" patent hot-coke conveyor

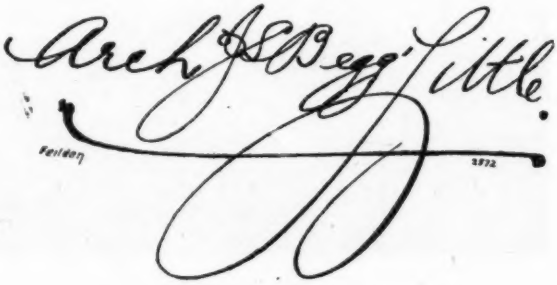
delivering to elevator, and this elevator feeds the cross conveyor shown on Photo 9. This delivers to cart, barge, or truck, and surplus coke is loaded on to stock heap, as shown.

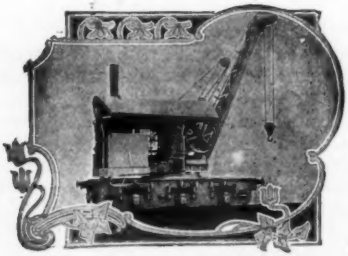
The two cross conveyors shown on Illustration 10 are fixed in the roof of a building some 73 ft. above ground-level, and are for carrying coal received from elevators to long conveyors fixed over the storage tanks in an inclined retort-house.

Details of a double-chain picking conveyor used for cement are shown on Fig. 11. These plate belts can be used for a large variety of substances which the ordinary bucket or scraper conveyor could not advantageously handle. They are cheap, and yet can be worked with very little expenditure of power for many years with hardly any upkeep cost.

The form of transporter shown on Photo 12 can be put down in many places where ordinary conveyors would not be applicable. Especially is it useful when materials in quantities have to be carried through long distances over uneven ground. The photo was taken at a cement works on the Thames, where the plant is in operation receiving coke from a crane which unloads boats, and the ropeway is so arranged that coke can be deposited at any point along the line.

Space will not permit me to extend the present article in describing the very complete and efficient plant put up by Hickman's (Limited) Ironworks, Staffordshire, to deal with their basic slag; or deal with other examples of conveying plants interesting to users of fuel and iron; so in conclusion I may add that it is in the power of the automatic material transmitter manufacturer to provide you with appliances to meet your views in almost any direction and extent; so lay your views before him and learn whether you are throwing money away, and tearing the hearts out of your employees by extracting from them work which should be accomplished with their skilled assistance rather than laborious exertion.





The Development of the Ferranti Rectifier.

By W. E. WARRILOW.

MR. WARRILOW was born at Martley in Worcestershire in 1877, and was educated at the King's School, Gloucester, where he obtained the Dean of Gloucester's Prize two years in succession.

Mr. Warrilow commenced his electrical training in the service of the Cheltenham Corporation Electric Supply undertaking. After being engaged for some time with the Torquay Corporation, Mr. Warrilow entered the Switch and Rectifier Department of Messrs. Ferranti, where he carried through the designs of a special switch-gear for the Huddersfield Corporation. Mr. Warrilow was then appointed Engineer-in-charge at the works of the above body, superintending the erection of the new switch-board and being responsible for the running and repair of the electrical plant.

Subsequently, Mr. Warrilow returned to Messrs. Ferranti, and is at present engaged upon the designs for 10,000 volt switch-gears for power and lighting purposes.

BEFORE introducing the reader to the piece of apparatus forming the subject of this article, it will be necessary to describe the various causes which have led to the production of the rectifier. By adopting this course, it will be easier to make the subsequent explanations clear than if the apparatus was described without some statement being made of those particulars which were instrumental in bringing about its manufacture.

The first practical utilisation of electrical energy for lighting purposes was by means of arc lamps, and though the principal stimulus to electric supply has been given by private consumers using incandescent lamps, the problem of the application of arc lamps to street lighting has had to be met. A satisfactory solution of this problem is more necessary when it is considered that the supplying of street lamps enables the engineer to run his machines at higher load after the private consumer has put his lights out, *i.e.* during the all-night shift, the time of least demand. From almost the outset of electric supply there have been two distinct systems of generation adopted, that by alternating currents (of high tension) and that by direct currents (of low tension). The relative advantages of one method over the other cannot be discussed here; suffice it to say that in the production of light by an arc lamp the direct current was superior to its rival. Direct currents were, however, unsuitable for supplying energy over scattered districts; the alternating current system of high pressure generation and transmission, with low pressure distribution, being especially suitable for such large areas. The principal differences between arcs produced by the respective currents were very marked. The upper carbon of the direct current lamp was consumed at almost twice the rate of the lower carbon, and was almost twice the diameter; consequently it overlapped the lower carbon considerably. When current passed, apparently, from the upper to the lower of the two carbons, a crater was formed at the end of the top carbon, and this recess became so intensely heated that its

concave form acted as a reflector to the light rays. The lower carbon being of smaller diameter allowed these rays to pass unobstructed in a downward and outward direction, thus greatly increasing the illuminating power of the lamp by the provision of an automatic reflector.

The alternating current arc did not produce these reflecting properties; its carbons being of an equal diameter and burning away at an equal rate. A reflector hung over the arc gave it a certain advantage in distributing the rays, but this did not equal the distinct features of the direct current lamp.

The difference in the illuminating power of the two arcs was proved by experiment to be strongly in favour of the direct current lamp. Professor Fleming, in 1895, published in the *Electrician* results of tests which showed that for a 582-watt lamp the direct current arc gives 1·16 mean spherical candles per watt; whereas, with a 601-watt alternating current arc, 83 periods, only 0·51 mean spherical candles per watt were obtained. A periodicity of 50 gave better results, ·547 mean spherical candles being obtained from a lamp taking 596 watts.

It will be seen from the foregoing that the alternating current engineer was seriously handicapped by the inefficiency of his arc lamps at the outset. Street lighting was a most desirable adjunct to his station, and it was moreover necessary that it should be as efficient as possible,

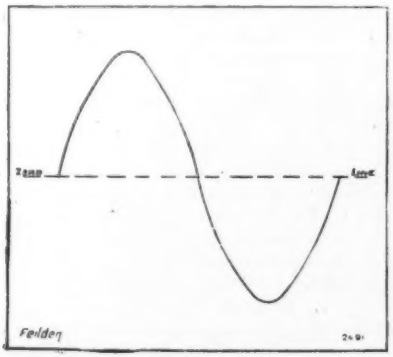


FIG. 1.—ALTERNATING CURRENT CURVE.

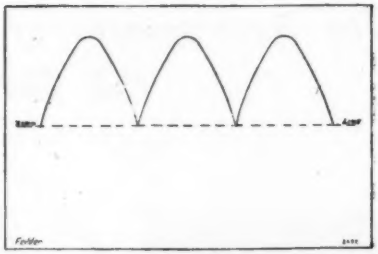


FIG. 2.—RECTIFIED CURRENT CURVE.

satisfying both himself and the public. In some of the earliest cases, the difficulties attendant on the alternating current arc seemed so impossible of immediate solution that a separate continuous current arc-lighting plant was installed by the side of the alternators in the station. Such an arrangement was not only illogical, but proved singularly inefficient, though it served to fill the gap until the appearance of more efficient apparatus. The pressing need for good street-lighting, however, still kept the question open; the engineer being even more desirous of meeting the demand from one type of generating plant. This led to the erection of alternating current arcs connected either:

(1) Three in series on a 100-volt circuit, or separate 100-volt transformers;
(2) Transformer for each lamp;
(3) A number of arcs in series off a transformer giving varying voltage and constant current.

These attempts, though very laudable as illustrating that the problem was being boldly met, did not equal the results given by the direct current arc; consequently the solution had to be sought elsewhere. The fact that an alternating current *per se* was unsuitable for efficient arc lighting caused the introduction of a piece of apparatus which changed the nature of the current so that for arc lighting it gave results equal to those produced by a direct current.

The current induced in the armature of an alternator changes its direction of flow a certain number of times per second

varying from 40 to 100, according to the design of the machine. From zero the current rises to a maximum in one direction, falls to zero and rises to a maximum in the opposite direction, falling again to zero, and so on; the cycle or alternation being diagrammatically represented by Fig. 1. If, however, a commutator in circuit with the armature is fixed on the alternator shaft, and so arranged that at the moment of current reversal in the armature the commutator moves forward, the alternating current will become a uni-directional but interrupted current. Such an arrangement was adopted on the earliest alternators which supplied current to arc lamps in lighthouses on the coast of France. Subsequently the principle was embodied in a separate apparatus receiving current from the alternator bus bars. The commutator was actuated by a motor turning in exact synchronism with the alternator, and the same result was obtained as when the commutator wsa fixed to the shaft of the generator. A diagram representing the resultant current is shown in Fig. 2, where it will be clear on comparison with Fig. 1 that the current rises and falls on one side of the zero line only. It will be seen that the feeding of arc lamps from one generating plant of the alternating current type has been gradually arrived at by patient experiments, and the various difficulties encountered have been described.

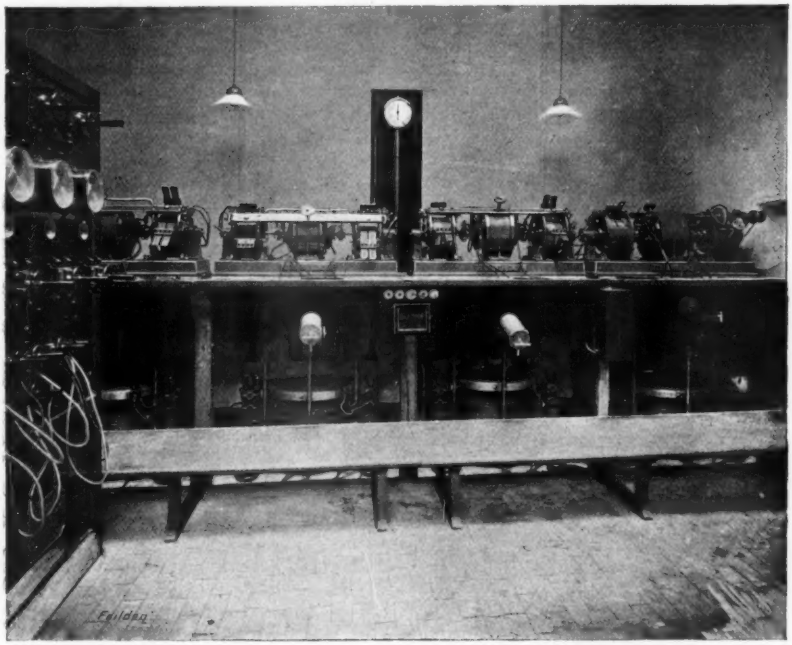


FIG. 3.—RECTIFIERS AT THE PORTSMOUTH CORPORATION ELECTRICITY WORKS.

An account of the development of the rectifier may now be entered into. The introduction and the manufacture of this plant has been in the hands of one firm only, Messrs. S. Z. de Ferranti, Ltd., and

though the field has been quite free from competition, the necessities for improvements have been recognised, and have resulted in the production of a most efficient piece of apparatus. The first instalment of rectifiers was at the Portsmouth Corporation Electricity Works in 1894, when four units with their attendant switch-gear were laid down. Fig. 3 is a photograph of the machines and a portion of the switch-board, which may be seen at the left-hand of the illustration. Each rectifier consisted of a synchronous motor having two commutators, and a constant current transformer. This latter, which may be seen underneath the motor table, consisted of fixed primary coils, and secondary coils capable of adjustment by means of a link motion terminating in a lever provided with a sliding weight. When under current, the coils tended to move apart by repulsion, and their distance could be regulated by the adjustment of the weight on the lever. The arrangement could thus supply a constant current at a varying voltage to the series of arc circuits.

The motor, driven by a low-pressure current, turned two single break commutators, one at each end of the shaft. The secondary coils of the constant current transformer were connected each to a commutator, which was coupled in series with its fellow commutator. Brushes set at 90 degs., and carried on a frame actuated by a handle, conveyed the current to and from the commutators. The right-hand rectifier is shown with grinding gear attached; this consisting of an emery wheel driven by the motor for the purpose of facing up the commutator when it has become worn.

The switchboard is fitted with ammeters, indicators for showing the direction of the current, reversing switches, and plug-cords for placing any rectifier on any circuit.

The space occupied by these first machines necessitated the introduction of a more compact unit, and Fig. 4 illustrates the next stage in the development, in which the apparatus is practically self-contained. The constant-current transformer has its coils arranged vertically, and the core is fixed to the standards which form the legs of the motor base-plate. The motor is provided with a double-break high-tension commutator at one end of the shaft, while the other end is fitted with a commutator of similar break for the motor circuit. The transformer to the right of the rectifier body supplies the motor with low-pressure currents, the voltage of these being regulated by switches cutting in or out certain of the transformer windings. On the left of the rectifier may be seen the water-break switch for closing the arc circuits gradually. The two contacts of the switch, one of which is mounted in an insulator at the top of the water-holder, and the other

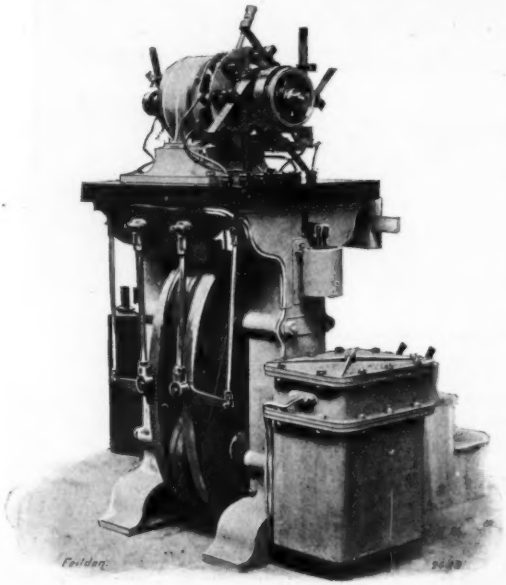


FIG. 4.—SELF-CONTAINED FORM OF RECTIFIER.

at the bottom of the latter beneath the water, are connected together with a brass rod insulated with a heavy ebonite handle and washer. The gradual insertion of the arcs enables the spark at the brushes to be more easily regulated, besides preventing undue strain on the arc lighting cables, by the steady increase of the pressure. The coils of the constant-current transformer are swung on knife edges, and by suitable links and weights their regulation may be easily effected. A dash-pot also tends to check any sudden movement of the coils.

A further modification is shown by Fig. 5, where the coils of the constant-current transformer are operated by a rack motion, provided with adjustable weights and a dash-pot. The high-tension brush-rocker has been strengthened with a view to steadiness, and an ammeter is inserted on the motor side for regulating the motor current. The high-tension commutator, which is similar to the previous type, can here be plainly seen. It consists of two inner and two outer rings. The former are divided into four parts in this case (though eight parts are made for high periodicities), two opposite segments being joined together, the other two being connected to the outer rings. The breaks between the segments of the inner rings are shown by Fig. 6, *A*, in which the principle will be made clear. By the adoption of this break the spark which is occasioned by the interruption of the circuit is broken up. The connections of a rectifier are shown by Fig. 7, where *A* shows the current passing in one direction to the brushes, and *B* illustrates the passing of the current in the opposite direction; while both *A* and *B* make it clear that a unidirectional current flows to the lamps. The brushes, one on each of the inner rings, are in turn short-circuited by a segment, and open-circuited to feed the outer rings by the following segment, at each quarter-turn of the commutator. This shows that whatever the direction of the current on the transformer side of the commutator, a current of one direction only will pass to the lamps as long as the motor is turning. Referring to the figure, *C* is the commutator, *W* the water-break switch, *A A* the secondary coils, *B* the primary coils, and *M* the motor transformer.

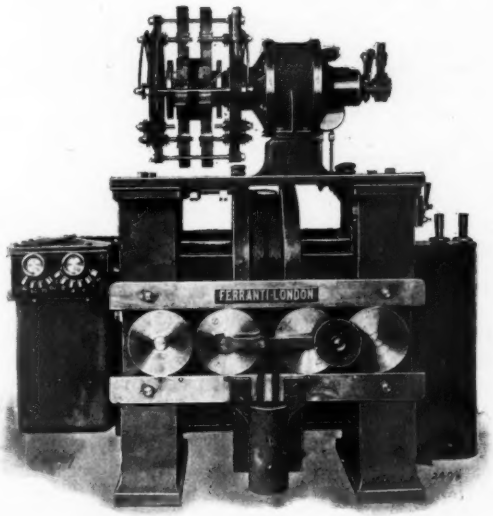


FIG. 5.—VIEW OF RECTIFIER SHOWING FURTHER MODIFICATIONS.

The motor connections are shown by Fig. 8. The armature or stator *A* is fixed —*i.e.* does not rotate, though it can be adjusted slightly, the fields *B* forming the moving portion of the motor; *C* is a two-way switch, *D* a 10-ohm resistance, and *E* a four-part commutator; while *F* is the regulating switch for varying the field voltage. When starting, the field is placed across the transformer secondary, in circuit with the 10-ohm resistance and in parallel with the armature. When synchronism is attained, the brushes in the meantime

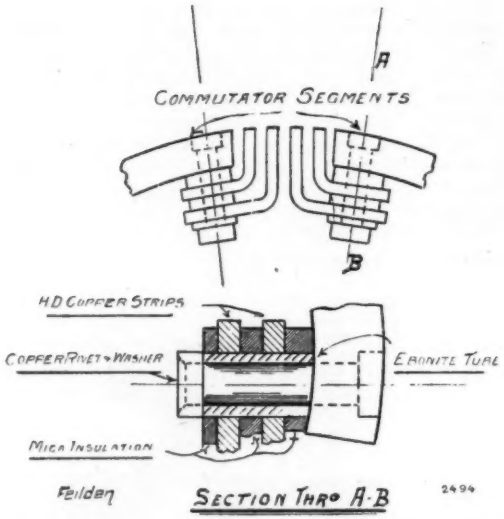


FIG. 6.—SECTION THROUGH COMMUTATOR, SHOWING BREAKS BETWEEN SEGMENTS.

having been moved forward about 90 degs., the two-way switch is put over, cutting out the 10-ohm resistance and placing the field, excited by a unidirectional current, in parallel with part of the armature. The most suitable voltage for running may be obtained by the regulating switch.

Fig. 9 illustrates a complete rectifier of the last pattern, with its switch-gear for three rectifiers and three circuits. Surmounting the whole switch-board is the high-tension voltmeter, protected by oil-break fuses and fitted with a plug which may be inserted in the sockets of any circuit for the reading of its pressure. The upper part of the body of the main board is fitted with slate panels which hinge forward on their lower edges to render the back connections accessible. Each panel is provided with plug and cord (kept in tension by a porcelain weight), plug sockets, pole indicator, and ammeter. The plugs and cords are connected to the ends of the circuit cables, the sockets being coupled to the rectified currents from the rectifier in such a way that by the insertion of a short circuiting plug two circuits can be put in series with one another and fed from one rectifier. The hinged panel deals with the rectified currents only; the alternating currents, to the primary of the constant current transformer, being passed through an oil-break fuse from one of two bus bars fixed below the hinged slates. Two of these fuses may be seen on the floor to the left of the rectifier. The currents supplying the above-mentioned bars are carried from the main switch-board through switch, ammeter and fuse, so that all arc circuits can be controlled from the central distributing board. After considerable experimenting, the rectifier has arrived at the standard type shown in Fig. 10, and comparison with previous makes will at once make the chief points of

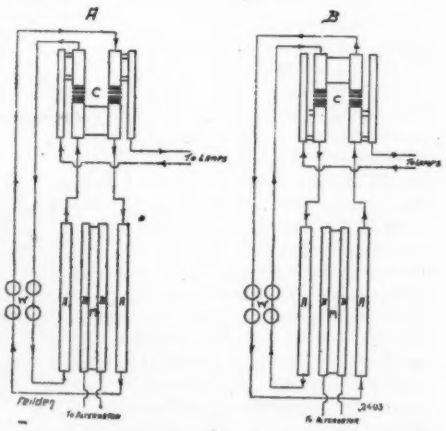


FIG. 7.—DIAGRAM SHOWING CONNECTIONS FOR RECTIFIER.

difference evident. The modifications have been effected with a view to greater safety and reliability. The chief alteration is the fixing of the high-tension brushes and the shielding of the commutator with a plate-glass guard. The adjustment of the spark effected by the rocking of the brushes in previous types is brought about by rotating the motor armature. The improvement in the appearance of the rectifier alone is a great feature of this change, which has also added considerably to the easy manipulation of the apparatus. The reliability of the synchronous motor is much increased by the lengthening of the motor bearings and the duplication of the brushes on the low-tension commutator.

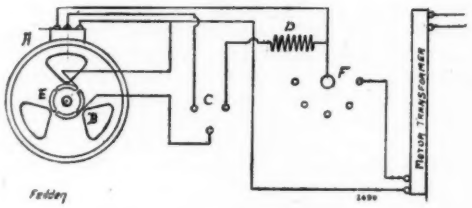


FIG. 8.—DIAGRAM SHOWING CONNECTIONS FOR MOTOR.

The constant current transformer has its coils mounted in frames which run on steel balls; the frames being linked to a dash-pot filled with a certain weight of shot. Regulation is thus carried out quite independent of adjustable weights, and friction of the moving parts is no greater when the coils are wide open than when they are close together. The motor transformer coils are "sandwiched" between the two fixed primary coils, thus dispensing with an external transformer, and minimising the space occupied by each rectifying unit. The water-break switch is made double pole and double break, and its insulation is such that it is impossible to receive a shock by coming into accidental contact with it. The water holder, moreover, is made free from leakage by a special construction which has given great satisfaction.

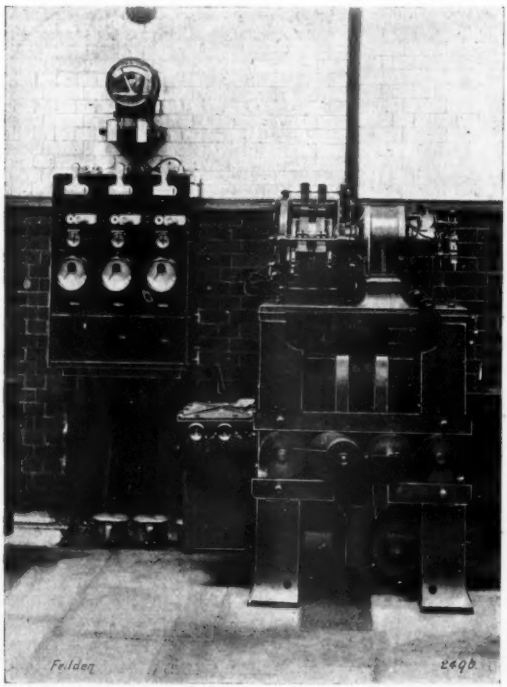


FIG 9.—LATEST PATTERN OF FERRANTI RECTIFIER.

The development of the rectifier having been considered, a few remarks on its advantages may now be made. First and foremost, the apparatus enables the alternating current engineer to compete with, if not excel, the direct-current system in supplying arc lamps from one generating plant, and the economies effected thereby are very marked when compared with the old plan of having two types of generators to supply

arcs. With a Brush arc lighter (30 kilo-watts) driven by its own engine, the mean efficiency was found to be about 50 per cent. This figure has been exceeded in America with large units, but such instances are rare.

For a modern steam alternator, an average efficiency of 89 per cent. may be taken as not unusually high, and for a rectifier an average of 90 per cent. will be a fair figure, so that the combined efficiency of alternator and rectifier will be about 80 per cent., as compared with 50 per cent. for separate arc lighting plant. The comparison, however, does not end here. A 30-kilo-watt arc lighter rope driven from a horizontal engine will occupy 500 sq. ft. of floor space, this leaves 2 ft. round the plant for attendance. A similar plant when direct driven would occupy only 220 sq. ft., so for each case a floor space of 16 and 7 sq. ft. per kilo-watt respectively is taken up.

A modern 300-kilo-watt alternator will occupy about 500 sq. ft. or 1·6 sq. ft. per kilo-watt, and if this alternator supplied 300 kilo-watt of rectifiers an additional 200 sq. ft. must be added to the above figure, making the total floor space occupied 2·3 sq. ft. per kilo-watt. Comparing this with the 30 kilo-watts of plant for rope or direct driving a Brush arc lighter, the balance in favour of the rectifier is very great, and its importance cannot be too clearly marked. The light given by a rectified current arc is practically equivalent to that supplied by a continuous current, as in each case the carbons are of different sizes, and a crater or reflector is formed in the top carbon.

Another point which is worth mentioning here is the possibility which the rectifier affords of increasing the flexibility of a lighting system. In a modern direct-current station it is usual to place a certain number of lamps (varying with voltage employed) in series across the mains, the combination being turned on and off from a certain lamp. This arrangement is cheap in its first installation, but it possesses the disadvantage of placing a most important section of the lighting beyond the control of the staff at the works. Moreover, should a breakdown to the plant occur at the station, all lights would be extinguished, by reason of both public and private supply being given from one set of mains. The same applies in the case of a fault on a main feeder. Where separate arc mains are laid, as is necessitated by the use of rectified currents, the two systems may be kept separate during times of heavy load (when mishaps are most likely to occur) by supplying the arc lamps from a separate

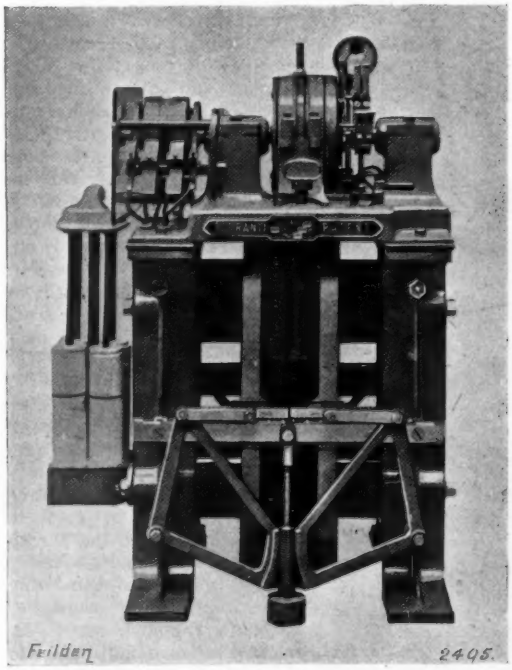


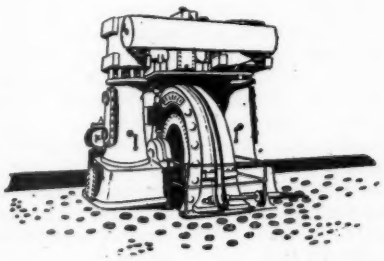
FIG. 10.—STANDARD PATTERN OF FERRANTI RECTIFIER.

alternator, which may, however, be run at or near its full output. When the "peak" of the demand has dropped, the two systems may be again connected together. This arrangement may seem illogical at a casual glance, but when the advantage gained by the independence of the two systems during the most trying hours of the supply are considered, the apparent absurdity of the system will disappear. A certain flexibility is obtained by lighting the two sides of a street by separate mains, but a breakdown of plant (by no means an impossible event) would probably extinguish all lights for a time. The development of the rectifier has occupied a comparatively small space of time, but the results have been none the less marked by that circumstance, and such a statement speaks well for the way in which manufacturers meet and overcome difficulties. That these difficulties have been very great is beyond question; but they have been as nothing to that obstacle to be surmounted which has prevented many a good thing becoming more widely known, viz., "prejudice." That there was some ground for reserve in adopting rectifiers in their earlier stages is true; such grounds, however, are no longer tenable, as the apparatus has stood the best possible test applicable—the test of time.

The rectifier, like any other form of apparatus, will, no doubt, in years to come be no longer used; but this will not alter the fact that it has met a pressing demand in placing the much-abused system of single-phase alternating current on an equal basis with its rival, the direct current, in the matter of street-lighting. Improvements in the alternating current lamp, either of the enclosed or open type, will be chiefly instrumental in dispensing with the services of rectifiers; but, until such changes are effected, the system may be reckoned upon to hold its own against all comers.

In conclusion, the author begs to thank Messrs. Ferranti for their kindness in supplying him with the photographs which illustrate this article.

W. W. Warnlow



The Town Refuse Problem, and its Relation to Steam Production.

By WILLIAM H. MAXWELL. Assoc.M.Inst.C.E.

(*Continued from page 441.*)

THE MELDRUM DESTRUCTOR.

The Meldrum "Simplex" Destructor is a modern type of furnace (see Figs. 4, 6, and 7), combining the efficient cremation of the refuse without nuisance with the production of a large amount of steam power. At Rochdale, Hereford and Darwen may be seen four cells of this type, developing some 275 to 350 i.h.p. per hour continuously, and installations have also recently been completed at Burton, Hunstanton, Blackburn, Shipley and elsewhere.

The general design of this destructor differs widely from that of those previously named, and does not in any way follow upon the lines of previous types.

The destructor is practically one long cell, fed and clinkered at four or five different furnace mouths according to the number of grates installed, and, by this means, an approximately uniform temperature is maintained throughout. The grate areas are arranged side by side, separated only by dead-plates. The ash-pit, however, is divided into sections corresponding to the grate areas, in order to localise the forced draught. Each section is closed air-tight by a cast-iron plate, and there is an air-tight door for the removal of fine ash.

The refuse is shot from the tipping platform over the cells into a "hopper" opposite and near the mouths of furnaces, and from here it is shovelled into the cells by hand. Hopper feeding direct into the furnaces may, however, be applied if desired.

For each furnace two patent Meldrum steam jet blowers are provided, and these deliver any required pressure of forced draught up to 6 ins. of water column. The degree of blast generally adopted is about 1·5 ins. of water. It has been ascertained at Rochdale, from careful tests made by condensing the whole of the steam from the nozzles by means of a long coil, that from 14 to 15 per cent. of the total steam generated by the destructor is expended in the "Blowers." At Darwen the percentage is about the same, thus leaving good net steaming results. It will be interesting also to note, by way of comparison, that at Shoreditch the electrically driven air fans also absorb 14 per cent. of the current produced.

The gases or products of combustion either are carried over the different grate areas and over a firebridge to the boilers or chimney shaft, or are taken off at the back of each cell into a flue which then conveys them to the boilers or shaft.

The grates are fitted with patent locking fire-bars to prevent lifting when the cells are clinkered.

After passing over the fire-bridge common to all the grates, the heated gases enter a combustion and settling chamber, the temperature of which, by actual test, is found to be between 1800° and 2200° Fahr. This high temperature is adequate to ensure the perfect cremation of the vapours from the refuse, and the gases may with safety be passed on to the boilers, in which from one to two pounds of water can be evaporated per pound of refuse.

The heat in the flue gases, after leaving the boiler, is again made use of in heating the air supplied to the furnaces. This is done by means of an air-heater or continuous regenerator placed just beyond the boiler before the gases escape away into the main flue leading to the chimney shaft. The air heater consists of a number of cast-iron pipes, through which the gases pass. The cold air circulates round the outside of the pipes, and is

delivered to the furnaces through the patent Meldrum blowers at a temperature of about 300° Fahr.

The system also includes a method of heat storage by the provision of high-pressure boilers of large capacity; the object being that, when energy is required, as for electric light or power works, a reserve of steam may be accumulated during periods of light load for use at times of maximum demand.

The process of clinkering is assisted by the use of tipping bars or dead-plate, arranged so that the red-hot clinker is dropped into a trolley in the ashpit, where it is allowed to remain for a short time to

supply of refuse of about 40 tons per day.

At the Corporation Sanitary Works, Rochdale, a destructor of the Meldrum type has been in successful use for several years, and consists of four "Simplex" grates, having a total grate area of 90 sq. ft., with two 30 ft. by 8 ft. Lancashire boilers, the steam from which is used in connection with the manufacture of manure. The refuse burnt is ordinary town refuse, without screening of any sort, and the furnaces consume from 53 to 66 lbs. of this material per square foot of grate area per hour. The consumption of a low temperature furnace,

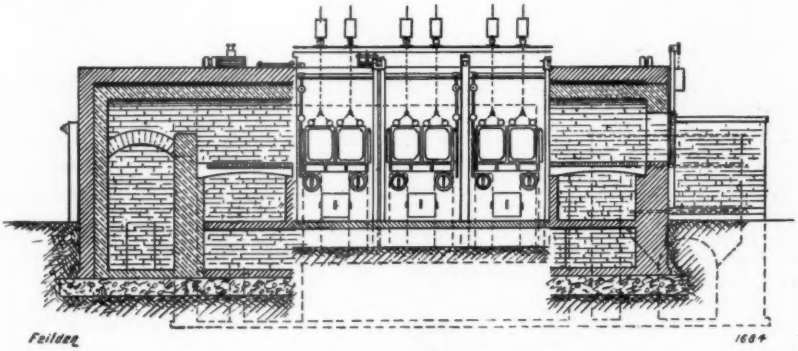


FIG. 4.—THE MELDRUM DESTRUCTOR (SECTIONAL ELEVATION).

give off the greater portion of its heat, and is then removed in its less heated state. The firing doors are made in two parts, lined with firebrick, and each part is worked with a counterbalance weight so that the stoker need lift one half only at a time, thus screening him from the great heat of the cell.

There is a mattress chamber, so arranged that the gases from the burning material pass over the fire and under the glowing arch of the grates before entering the combustion chamber.

A Meldrum destructor having 90 sq. ft. of grate area, and consuming at the rate of 40 to 45 lbs. of refuse per square foot of grate per hour, will be adequate for a population of 50,000 yielding a total

burning about 6 tons per cell per 24 hours with a grate area of 25 sq. ft., works out at about 22·4 lbs. per sq. ft. as compared with the above.

The furnace gases evaporate from 1·5 to 2 lbs. of water per lb. of refuse burned, and the total i.h.p. developed per hour, calculating upon 20 lbs. of steam per i.h.p. hour, is about 350 h.p. The whole of this power is not at present utilised, and a portion is allowed to run to waste.

The cost of burning the refuse is 7·5*d.* per ton for labour, or, including supervision, about 10*d.* per ton. Houses are erected close up to the Rochdale Destructor Works, being separated only by the width of the street.

The following results of the perform-

ances of this destructor were ascertained by the superintendent of the works at trials conducted under ordinary everyday working conditions:

	Test A.	Test B.
Duration of test	6 hours	6·5 hours
Total refuse destroyed	11·4 tons	14·3 tons
Refuse burned per hour (90 sq. ft. grate area)	4,256 lbs.	4,945 lbs.
,, ,, per sq. ft. of grate area	47·3 lbs.	54·9 lbs.
Number of boilers used (plant consists of two 30 ft. × 8 ft. Lancashire boilers)	two	one
Temperature of feed water	53° Fahr.	52° Fahr.
Total water evaporated	42,072 lbs.	47,400 lbs.
Water evaporated per hour	7,012 lbs. = $\frac{7,012}{20}$ = 350 i.h.p.	7,290 lbs
Equivalent evaporation from and at 212°	8,431 lbs.	8,820 lbs.
Water evaporated per lb. of refuse	1·64 lbs.	1·47 lbs.
Equivalent evaporation from and at 212°	1·97 lbs.	1·78 lbs.
Average steam pressure per sq. in.	113 lbs.	114 lbs.
Percentage of CO_2 in products of combustion	15·9 lbs.	.....
,, ,, CO ,, ,, ...	nil	... ..
Percentage of free oxygen	2·2	.....
Highest temperature in combustion chamber...	1,988° Fahr.	.....
Lowest ,, ,, ,, ...	1.290° Fahr.	.....
Cost of labour for burning the refuse	7½*d.* per ton	7½*d.* per ton

At the Hereford Sewage Outfall Works two destructor furnaces (with four cells) were erected in 1897 by Messrs. Meldrum Bros. of Manchester, the steam generated being employed in pumping sewage and other work. Fig. 5 is a general view of the destructor buildings. About 54 lbs. of refuse are burnt per sq. ft. of grate per hour, evaporating 1·82 lbs. of water (from and at 212° Fahr.) per lb. of unscreened ashpit refuse, giving a total water evaporation of 2,980 lbs. per hour per boiler, which is equivalent to $\frac{2,980}{20}$ = 149 i.h.p. per hour at 20 lbs. of steam per h.p. The boilers, of which there are two of the Galloway type, are 22 ft. long by 6 ft. 6 in. in diameter. There is no regenerator.

At a trial conducted by the City Surveyor in 1898, the plant gave the results which are tabulated on following pages, and thus will be of interest.

A Meldrum destructor (Figs. 6 and 7), of 104·5 sq. ft. grate area has recently been laid down at Darwen in conjunction with the Corporation Electricity Supply Station, and commenced working in September, 1899. The heated gases from the furnaces, after passing through the combustion chamber, heat two Lancashire boilers (each 30 ft. by 8 ft.), and then proceed to the regenerator placed at the end of each boiler. By this means, the air which is drawn into the furnace by the forced draught is heated to 350° Fahr. Each boiler works up to a pressure of 200 lbs. per sq. in.

The electric plant at present consists of three direct-coupled units in position, two of these, consisting of Bellis engines and Siemens bipolar generators, having a capacity of 150 kilowatts, the engines being rated at 250 h.p. The third set is a 450-h.p. Bellis engine and a 300-kilowatt multipolar generator by Messrs. Mather & Platt, while another unit is being supplied by Messrs. Bruce, Peeble & Co. The engine beds for two more units have been prepared, and these units will be considerably larger. There is space in the present building to provide for at least 2,500 h.p. before it will be necessary to extend.

Besides running the lighting load of the town, energy is also now supplied for the Corporation tramway system, which was

Description.	Result.
Duration of test	10 hrs.
Class of fuel burned	Unscreened ashpit refuse
Total weight of refuse burned	19,712 lbs.
Weight refuse burned per hour	1,971 lbs.
,, burned per sq. ft. of grate area per hour	54·75 lbs.
Percentage of clinker	25·56 per cent.
Total water evaporated	29,800 lbs.
Water evaporated per hour	2,980 lbs. $= \frac{2980}{20} = 149$ i.h.p.
,, ,, per lb. of refuse, actual	1·51 lbs.
,, ,, ,, ,, from and at 212° Fahr. ...	1·82 lbs.
Temperature of feed-water	48° Fahr.
Average steam pressure	70·92 lbs.
,, ,, at blowers	65·21 lbs.
,, air pressure under grates by water gauge	1·82 ins.
,, chimney pull, by water gauge	·375 ins.
,, temperature by copper test in combustion chamber ...	2,000° Fahr.
,, ,, of waste gases at chimney base	715·12° Fahr.
,, percentage of CO_2, by econometer	16·27 per cent.
,, ,, ,, free oxygen, by Orsat apparatus	3·74 per cent.

opened about a year after the completion of the electricity works.

The total length of the tramway line is 2·83 miles, and is worked jointly with the Blackburn Corporation, the cars of both authorities running throughout the route. The cars have to climb gradients in one case as steep as 1 in 14. A large proportion of the power required is obtained from the destructors, and with the normal tramway or lighting load taken singly it is unnecessary to use any coal. The refuse, consisting of ordinary town refuse, with fish-market, and abattoir offal, is thrown on the fires from iron pails holding about 80 lbs., and although temporarily deadened, the fires are not sufficiently interfered with to affect the supply of steam. The charts from the steam register show that a regular pressure, averaging about 183 lbs., is maintained by giving reasonable care and attention to the steam gauge.

The following figures were obtained at a recent trial of the capabilities of the plant, in which every effort was taken to ensure actual daily working conditions :—

Description.	Result.
Duration of test	48 hours (continuous)
Nature of refuse = unscreened ashpit refuse 61·88 tons, slaughter-house and fish-market offal, 2 tons ; average percentage of moisture, 35 p.c.	
Total quantity of refuse destroyed	63·88 tons
,, weight of clinker residue	19·5 tons (30·6 per cent.)
Temperature of feed water, average	185° Fahr.
Water evaporated per lb. of refuse, actual	1·48 lbs.
do. do. do. from and at 212°	1·55 ,,
Average steam pressure per sq in.	183 ,,
do. temperature of combustion chamber	1,633° Fahr.
Highest do. do. over (copper melted five times)	2,000° ,,
Lowest temperature of combustion chamber	1,201° ,,
Average temperature of flue after leaving boilers	703° ,,
do. do. do. regenerator	585° ,,
do. do. feed air from regenerator	328° ,,

Figs. 8, 9, 10, and 11 are views of the inside of the destructor house at Darwen, showing the range of cells, furnace doors, mode of stoking, etc.

The Hunstanton Urban District Council recently completed the erection of a Meldrum Destructor, designed for dealing with 12 tons of unscreened refuse per day of 24 hours, and for producing an evaporation of 40,000 lbs. of steam in a

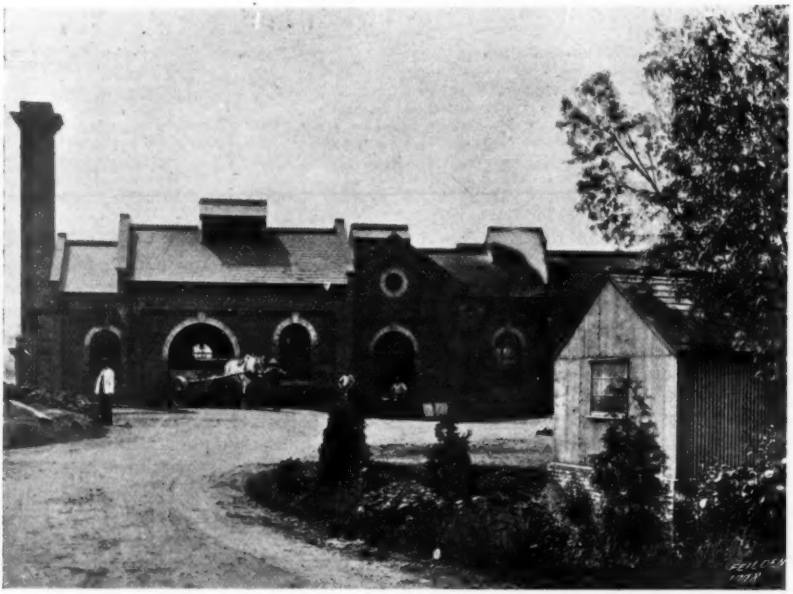


FIG. 5.—HEREFORD DESTRUCTOR BUILDING.

Cornish boiler, which is designed for a working pressure of 100 lbs. per sq. in. This is the first destructor of this type constructed in accordance with Meldrum's patent "regenerative" system, the aim of which is to provide a simple and effective means of heating the whole of the air supply to the furnaces by the absorption of heat from the chimney gases.

The destructor cells and combustion chamber are situated at the front of a Cornish boiler, and at the rear is a Schwoerer superheater, placed in the line of the furnace gases, to dry the steam passing from the boiler to the engines at the pumping station. The furnaces are hand-fired, and are of the general type, as already described. The blast is forced into the closed ash-pits by two of Meldrum's patent steam-jet blowers (one to each ash-pit), having independent steam connections from the boiler to the jets. By this means one-half of the furnace grate may be working at full blast while the other is shut off for clinkering, and it is also considered that this arrangement helps to keep the temperature of the combustion chamber constant and the boiler pressure steady. The steam to the boilers is passed through two superheaters, let into the cavities in the furnace lining, to check condensation and increase the efficiency of the blowers.

The blowers are coupled to a cast-iron box in the ash-pit, which connects to the open end of an air conduit passing under

the cells and boiler-setting and connecting with the "regenerator" in the rear. The regenerator consists of a nest of cast-iron tubes of small diameter, and through which the cell gases are conveyed before they enter the main flue. Air is drawn by the blowers, which passes round the outside of these heated tubes, raising it to a temperature of 350 degs. Fahr., for supplying the furnaces and thereby maintaining its higher temperature. The gases from the furnace, after passing the fire-bridge into the combustion chamber, go through and around the boiler and the Schwoerer superheater, then through the regenerator tubes and into the main flue to the chimney.

At Nelson a Meldrum regenerative refuse destructor has been recently completed. (See General View, Figs. 12 and 13.) The steam power derived is considerable, and the Corporation are considering the laying down of a scheme of electric traction to utilise the available power. The plant will probably deal also with the refuse of the neighbouring authority. In the Nelson installation a special hopper (Fig. 12) has been designed for dealing with the butchers' and fish market offal in an expeditious and sanitary manner, the material being shot into a dead hearth at the extreme end of the furnace, the gases from the drying refuse having to pass over the whole length of 25 ft. of incandescent fire, and then through 14 ft. of the combustion and dust-settling chamber before passing to the boiler, whereby all possible fear of any fumes passing away uncremated is eliminated. Interesting results of a test conducted in December, 1900, are given below. The boilers, however, were not clothed at the time the test was made.

The authorities at Shipley, Yorks, have put down a Meldrum destructor at the Sewage Works to deal with the town refuse, and to pump a normal flow of sewage of about 750,000 gallons per day through a lift of 47 ft. The refuse is of a mixed character, largely composed of night soil and other unpromising material, viewed from a steam-raising standpoint. It cont tains also a large percentage of marke-

Description.	Result.
Duration of test	9½ hrs.
Number of cells	4
Total grate area in sq. ft.	100
Lancashire boiler 30 ft. × 8 ft. heating surface	986 sq. ft.
Ratio of grate to heating surface	1 : 9·86
Refuse consumed, total	54,180 lbs.
,, ,, per hour	5,703 lbs.
,, ,, per sq. ft. grate per hour	57 lbs.
Percentage of clinker remaining	21·18 per cent.
Water evaporated	68,580 lbs.
,, ,, per hour, actual	7,220 lbs. = $\frac{7220}{20}$ = 361 i.h.p.
,, ,, ,, ,, from and at 212° Fahr. average	8,650 lbs.
,, ,, ,, ,, ,, ,, ,, maximum	9,380 lbs.
,, ,, per lb. of refuse, actual	1·266 lbs.
,, ,, ,, ,, from and at 212° Fahr.	1·516 lbs.
,, ,, per sq. ft. heating surface per hour, actual	7·3 lbs.
,, ,, ,, ,, ,, ,, from and at 212° Fahr.	8·77 lbs.
Average temperature of feed-water	63·4° Fahr.
,, steam pressure	118 lbs.
,, percentage of CO_2 actual	12·21 per cent.
,, temperature of combustion chamber (17 readings)	2,200° Fahr.
Highest ,, ,, ,, by melting pure nickel ...	2,650° Fahr.
Lowest ,, ,, ,, by thermophone	1,570° Fahr.
Average increase of temperature of air passing through regenerator ...	282° Fahr.
,, ashpit pressure	1·85 ins.
,, time taken to clinker one fire	5 mins. 36 secs.
Number of times each fire clinkered during test	5 times
Average time between clinkering fires	1 hr. 49 mins.

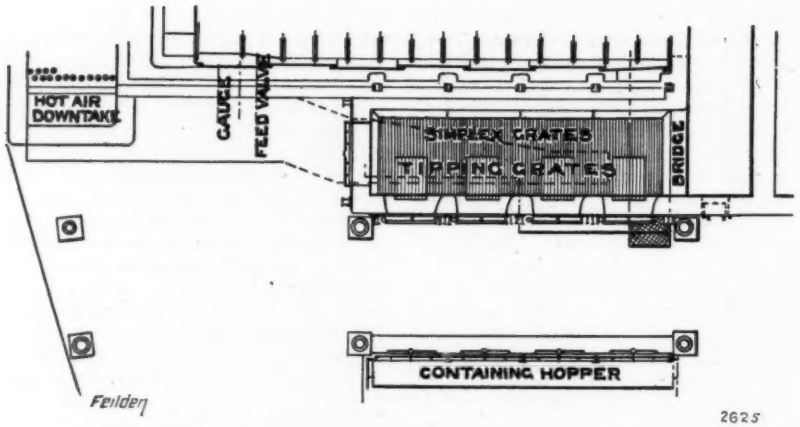


FIG. 6.—DARWEN DESTRUCTOR: PLAN SHOWING CELLS, HOPPERS, AND HOT-AIR CONDUIT.

garbage, butchers' and fish offal. An electric light plant is being installed to utilise the balance of steam over and above that required for pumping. The destructor was formally opened in March of this year.

An arrangement has been installed at Aldershot very similar to that in use at Hereford. The cells have been placed so as to utilise the existing Cornish boilers at the pumping station, and the saving in coal by the use of the refuse as fuel is given as equal to some £200 per annum. A further economy is effected by the use of the clinker obtained for filter beds, instead of coke, as formerly. There are two boilers, each 14 ft. by 4 ft. 3 ins.; and the cells are placed in front, each boiler being fired quite independently of the other. One boiler and its cells is quite equal to all demands for steam.

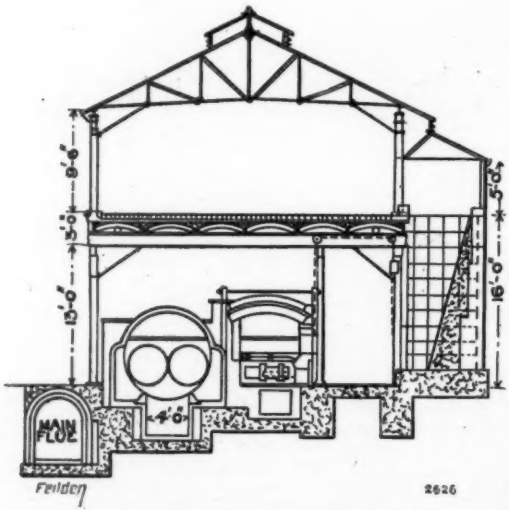


FIG. 7.—CROSS-SECTION OF DESTRUCTOR HOUSE.

At Burton-on-Trent a two-grate "Simplex" destructor replaced a Jones's cremator fitted to a bakery of four Manlove cells, the burning capacity of the new furnace being normally 20 tons per day of twenty-four hours.

The whole of the refuse at Wrexham is dealt with in ten hours per day by a four-grate "Simplex" regenerative destructor, and the taking of refuse from the neighbouring authorities is under consideration.

The Lancaster Corporation are installing a scheme similar to that at Darwen, and will use the surplus power for electric lighting and traction.

THE BEAMAN AND DEAS DESTRUCTOR.

The Beaman and Deas Destructor* is a modern high-temperature furnace, introduced about six years ago, and may be seen in successful operation at Warrington, Dewsbury, Leyton, Canterbury, Llandudno, Streatham, Rotherhithe, Colne, and Wimbledon. From Fig. 14, which illustrates the furnace as installed at Leyton, the essential features of this destructor may be observed. These include a level firegrate, consisting of simple type stationary bars; a fire-brick hearth, carried on girders and sloping at an angle of about 52 degs.; a high-temperature combustion chamber at the rear of the furnace and common to each pair of cells; a closed air-tight ash-pit with forced draught; and provision for the admission through small air-ducts of a secondary air supply at the fire-bridge.

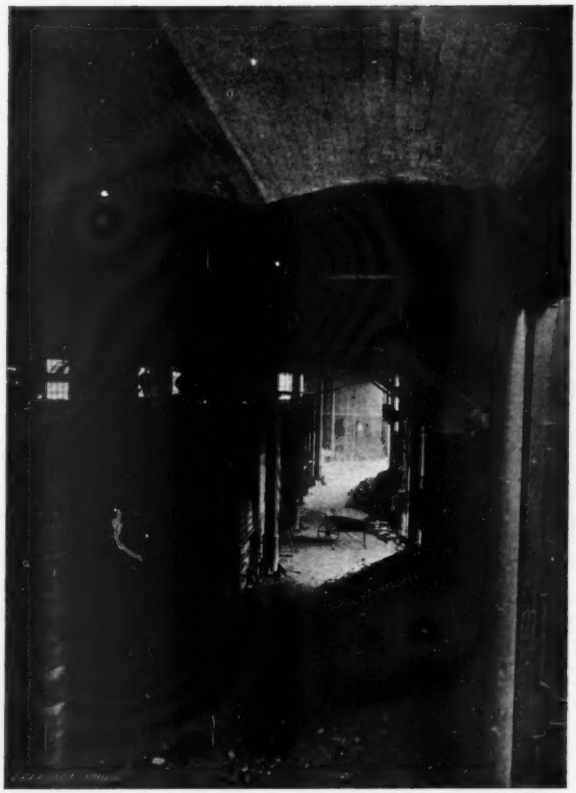


FIG 8.—MELDRUM'S REFUSE DESTRUCTORS AT DARWEN.

The material to be burnt is carted up a short incline to the top of a platform measuring about 8 ft. 9 ins. above the ground level, and is tipped direct over a hopper mouth about 1 ft. 6 ins. square, through which it is pushed on to a fire-brick hearth carried on T-irons, as shown in the accompanying illustration. At the bottom of the inclined hearth the refuse is received upon a firegrate area 5 ft. square, which is fixed level at a height of about 2 ft. 9 ins. above the floor of the ash-pit. The grate bars are of the ordinary stationary type, and are to be preferred to movable bars. They have spaces between them of only $\frac{3}{32}$ in., and the weight of fine ash passing through from a week's work of five days, and burning about 100 tons of refuse, only amounts to about 3·5 cwts.

Vertically under the fire-bridge, between the furnace and the combustion chamber, is an air culvert, on the top of which are the air-blast pipes. These pipes are usually about 12 ins. in diameter, and discharge into a hermetically closed ash-pit immediately under the fire-bars.

Air-draught is used, and is supplied from fans at a pressure of about 2 ins. of water, and is regulated by the use of

* Patent No. 15598 (1893) and 23712 (1893); also a Beaman and Deas Sludge Furnace, Patent No. 13029 (1894).

baffle valves worked by handles on either side of the furnace, convenient for the stoker in attendance. The forced draught tends to keep the bars cool, and to thereby prolong their life.

The vapours given off by the charge drying on the sloping hearth pass through the fire, directly over the fire-bars and over the fire-bridge. The bridge is perforated longitudinally with air-passages, which may be observed by reference to the figure. The miniature flues or air-passages lead from a grated opening on the face of the brickwork outside near the lever for regulating the draught. These passages require to be regularly kept clear, or they soon get blocked. The air passing through the hot ducts creates a strong draught, and the air in the course of its passage becomes heated, is discharged near the top of the bridge, and thus meets the fumes passing over into the combustion chamber, and furthers their more perfect combustion by means of this auxiliary supply of heated oxygen; the principle of the action being, in fact, somewhat similar to that of the Bunsen burner. The perforations for the exit of the air-supply should be situated where there will be the least risk of choking, and would give the best effect if placed on the fire-grate side of the fire-bridge, and not on the combustion chamber side, as shown, so as to get as much work done actually in the cell itself as possible. A practical difficulty, however, will be to keep these holes clear of obstruction, and provision must be made for frequent and easy clearance of same.

The combustion chamber, which attains an exceptionally high temperature, is provided with large iron doors at each end for the admission of infected or other articles, and also for access for periodical removal of fine ash from the flues. In order to utilise the high temperature attained, a boiler is usually provided to each pair of cells. The boiler shown in the figure is a water-tube boiler of the Babcock & Wilcox type, and is heated by the gases from the combustion chamber,

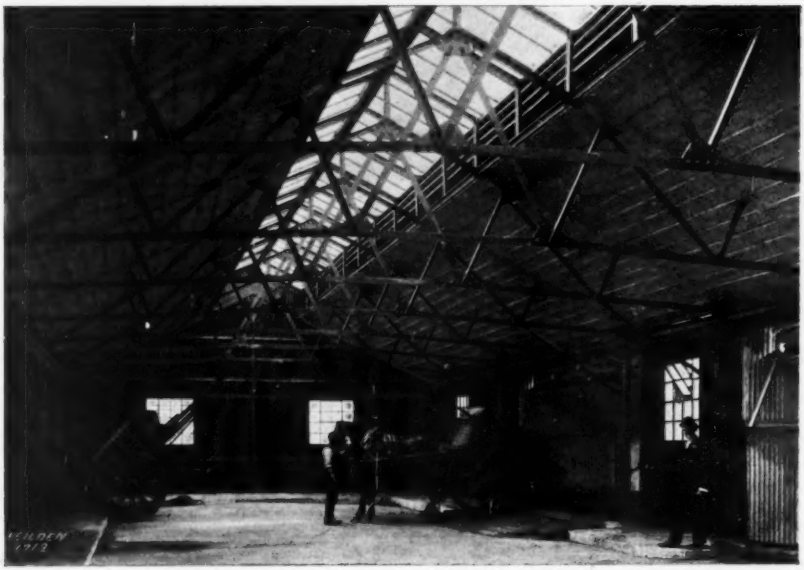


FIG. 9.—REFUSE DESTRUCTORS AT DARWEN: THE TIPPING PLATFORM.

which pass on their way to the main flue three times between the boiler tubes. A secondary furnace is provided under the boiler for raising steam with coal fuel when the cells are not in use.

The cells are, of course, to be worked in pairs. When one cell is being recharged with fresh refuse, and its temperature is low, the adjoining cell is at full red heat. Both cells discharge into one combustion chamber common to the pair, so that the heated gases from the hotter cell maintain the temperature of the combustion chamber, and so assist to thoroughly cremate the gases from the refuse in the other cell undergoing recharging. When properly managed, a fairly uniform and high temperature is thus maintained in the combustion chamber, preventing the escape of obnoxious vapours.

The action of the forced blast in the furnace throws up showers of small clinker particles, which fix themselves upon the roof of the cell in a stalactitic form. This coating covers the fire-brick lining of the cell, and protects it from the action of the great heat. The stalactites obtained from the crown of the arch consist principally of silica, alumina, oxide of iron, lime, magnesia, etc.

The Beaman & Deas destructor will properly consume about 20 tons of house refuse per cell for twenty-four hours, or about 75 lbs. of refuse per square foot of grate area per hour, each cell having an area of 25 sq. ft. of grate. At Llandudno, where this type of furnace has recently been laid down in conjunction with an electric lighting station, the amount of refuse burned per hour per square foot of grate area is 71·7 lbs.

At Leyton a battery of eight cells of this type deals with the house refuse and filter press sewage sludge from a population of over 100,000 persons, and as a rule either four or six cells are in use at the same time.

The material burned is of a most incombustible nature, the pressed sludge

FIG. 10.—MODE OF CLINKERING AT REFUSE DESTRUCTORS, DARWEN.

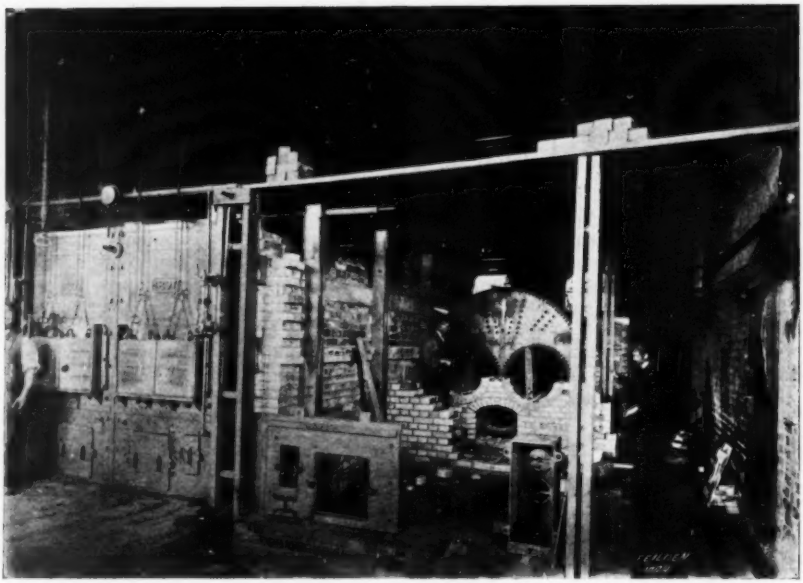


FIG. 11.—THE HEREFORD DESTRUCTOR IN COURSE OF CONSTRUCTION.

containing about 60 per cent. of moisture, and sometimes considerably more. This material, mixed in nearly equal proportions with the house refuse (which also is of a poor calorific value), is burned at the rate of about 17 tons per cell per twenty-four hours, or about 64 lbs. per square foot of grate area per hour.

Notwithstanding the incombustible nature of the mixture burned, a considerable amount of steam power is developed, equal to from 35 to 40 i.h.p. per cell per hour, at an average steam pressure in boilers of 105 lbs. The cost in labour of burning this mixture is about *1s. 7d.* per ton.

The steam is utilised for pumping low level sewage, lighting the works by electricity, driving sewage mixers, lifts, etc. No coal is used when the destructor is in use.

Both destructor and sewage works are worked without the slightest nuisance or inconvenience to the neighbouring properties, and a large building estate adjoining the site of the works is now being rapidly developed and built upon.

During the year ending March 31st, 1899, the destructor consumed 10,741 tons of house refuse and 8,568 tons of pressed sewage sludge cake, making a total of 19,309 tons, or about 60 tons per day. The amount consumed is upwards of 3,000 tons more than that burned during the previous year.

The total amount of residue during the year was 5,593 tons of clinker and 485 tons of fine ash, making a percentage of 31·4 per cent. of the material dealt with.

The total cost of labour and materials in working the destructor station for the year was £1,906, of which amount £1,590 was spent in wages. The cost in labour and material of dealing with the house refuse and pressed sludge therefore works out at *1s. 11·7d.* per ton. Against this there are important assets in the shape of steam power derived for running the sewage works adjoining, lighting the

premises with electricity, and sale of clinker.

Four Beaman & Deas cells are installed at Llandudno in conjunction with the electric light station. The cost in labour of burning the refuse is *1s.* 3·25*d.* per ton, and the cells consume 71·7 lbs. of refuse per sq. ft. of grate area per hour. The percentage of clinker is rather large, amounting to 30·5 per cent. of the bulk. It is disposed of for filling-up purposes.

One pound of refuse evaporates ·72 lb. of water, and the average steam pressure is 143·5 lbs. per sq. in. The power required to drive the fan for the forced draught is 7·4 kilo-watts of electric current, and the consumption of refuse per hour per pair of cells is 1·6 ton.

The total output of the electric station is 250 kilo-watts, or $\frac{250 \times 1{,}000}{746} \times \frac{100}{90} =$ 373 h.p., the town being a pleasure resort. The value of the refuse varies very materially according to the time of year, but it may be taken that the steam power as now derived from the destructor is about 105 h.p. The total capacity of the boilers installed is about 600 h.p. Each of the three boilers is capable of evaporating about 4,500 lbs. of water per hour at a working pressure of 150 lbs. per sq. in.

The destructor and boiler house, which measures 75 ft. 6 in. × 45 ft., contains four Beaman & Deas cells, and three Babcock & Wilcox boilers. The centre boiler is used for hand-firing with coal only, whilst the two outside boilers receive their heat from the destructor furnaces, but these also, should occasion require, can be fired by hand with coal.

The flues from the boilers and destructor furnaces are arranged in duplicate, so that they may be cleaned out without closing down the plant, which is an important consideration for the continuous running of the electric plant.

The boiler feed-pipes are so arranged as to feed direct or through a Green's economiser, the scrapers on which are driven by a small motor. The economiser consists of 192 pipes arranged in one group fitted with deflectors at the back. The main exhaust is carried outside the building, and provided with an automatic valve, so that the exhaust may go either to the condenser or to the atmosphere. The condenser, placed immediately outside the boiler-room, is of the Ledward evaporative type, and has a total of 300 radiating pipes of oval section, and is capable of condensing 7,500 lbs. of steam per hour. It is erected over a large cast-iron tank of 4,000 gallons capacity. The air and circulating pumps for the condensing plant are driven direct by a vertical compound engine erected by the Sunderland Forge Company.

A combined destructor and electric lighting plant has recently been laid down at Canterbury, and commenced working in November, 1898. The plant consists of two Beaman & Deas furnaces arranged side by side, fed by a large sloping refuse hopper. There is no inclined roadway, the refuse being raised to the tipping platform by an electric lift. A Babcock & Wilcox boiler, with 1,619 sq. ft. of heating surface, is arranged in the line of the main flue, and close up to the cells, so as to get the full benefit of the heat after leaving the combustion chamber.

The leading principles which governed the design of the buildings and the disposition of the plant were :—

(1) The prevention of dust from the refuse entering the engine-room and so damaging electric plant.

(2) The working of the destructor either alone or in combination with the electric plant.

(3) The capacity of the destructor cells to be such that each day's refuse collection should be properly burned within the space of 10 hours, commencing at noon daily and continuing till 10 p.m.

(4) The power generated during the day hours of light load to go to charge the electric accumulators.

(5) After accumulators are charged the night load will be commencing, and will more than absorb the power given off by the destructor.

The builders of the furnaces undertook to provide two cells, with a duty of 15 tons in 12 hours (being at the rate of 30 tons per day), to be completely destroyed by burning under forced draught to a hard, innocuous clinker ; the steam production

to be equal to an evaporation by the destructor gases alone of 2,800 lbs. of water per hour from and at 60 degs. Fahr., and at a pressure of 125 lbs. per sq. in., being at the rate of 1 lb. of steam per 1 lb. of refuse consumed. This rate to apply for a period of 10 hours daily, leaving the remaining two hours as a margin for getting up the heat of the furnace, etc. The temperature of the combustion chamber to be 2,000 degs. Fahr., and an innocuous

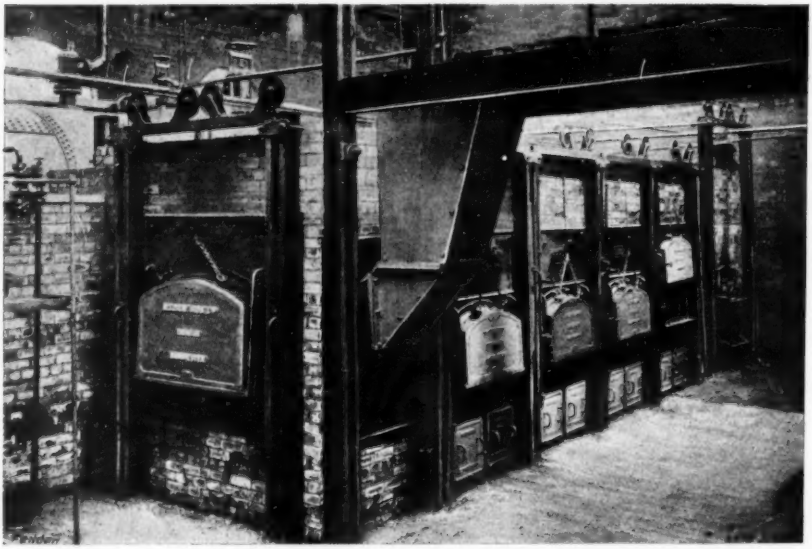


FIG. 12.—NELSON DESTRUCTOR. VIEW OF CELLS SHOWING OFFAL HOPPER, ETC.

clinker, amounting to from 18 to 30 per cent. by weight of the refuse burnt, to be produced. The electric motor to run sparklessly, with a rise of temperature not exceeding 75 degs. Fahr.

With the Canterbury installation, laid down as it is in conjunction with the electric station, the production of steam-power from the destructor is of almost equal importance with the cremation of the refuse. Careful tests have therefore been carried out by the city surveyor, and also by the corporation's consulting engineer, to accurately determine the actual performance of the plant in this direction. The first test, conducted by the city surveyor in October, 1899, gave results in steam production (see opposite).

The evaporation result obtained—viz., 1·32 lbs. water—was therefore in excess of the guaranteed amount by 32 per cent. The refuse used in the trial was not selected or in any way sorted beyond the picking out of the large tins. It consisted of the ordinary day's collection, and the weather prevailing at the time was dry and mild. The City Surveyor is of opinion that during the dry, cold, and frosty weather, the results would surpass the above, whilst during the summer they would not approach this high efficiency.

The evaporation was at the rate of 4,717 lbs. of water per hour; that is, taking 20 lbs. of steam per i.h.p. per hour, the destructor is capable, under the conditions of the test, to yield $\frac{4,717}{20} = 235$ i.h.p. per hour, and with the exception of the steam used in pumping and heating the

Description.	Actual Results of Trial.	Performance guaranteed by Contract.
Total weight of refuse burned	29,400 lbs. = 13·125 tons	24,500 lbs.
Time occupied in cremating the refuse	8·75 hours	10·5 hours
Refuse cremated per hour	3,360 lbs. = 1·5 tons	2,800 lbs.
Total evaporation	41,280 lbs. of water	33,600 lbs. water
Rate of evaporation per hour	4,717 lbs. ,,	2,800 lbs. ,,
Average temperature of feed water	125° Fahr.	60° Fahr.
Average steam pressure	132·2 lbs.	125 lbs.
Evaporation per 1 lb. of refuse (actual)	1·404 lbs. water	—
Evaporation per 1 lb. of refuse (reduced to contract standard of 60 degs. temperature of feed water and 125 lbs. pressure)	1·32 lbs. ,,	1 lb.
Evaporation per 1 lb. of refuse, from and at 212 degs. Fahr.	1·59 lbs. ,,	—

feed water and working the forced draught and lift, this power is available for external work in the electric undertaking.

So high a degree of efficiency in ordinary everyday working is scarcely to be expected as that obtainable on test, and it will be of interest to compare the foregoing results with the following data ascertained over a prolonged period of 200 hours :—

obtained above, but slightly even more favourable. The data obtained are tabulated at the foot of this page.

The maximum load carried by the destructor was 108 kilo-watts, and the minimum load 53 kilo-watts.

The percentage of clinker to the refuse burned amounted to 33 per cent., which is a rather large proportion.

Total refuse delivered and burned (estimated at 15·2 cwts. per load)	= 573,440 lbs. = 256 tons.
Time taken to burn above	= 200 hours.
Average rate of burning per hour	= 1·28 tons.
Total of evaporation (actual)	= 552,480 lbs.
Average evaporation per lb. of refuse burned	= ·986 lb.
,, ,, per hour	= 2,762 lbs. = $\frac{276}{2}$ = 138 i.h.p. per hr.

In the second test, conducted by the Council's Consulting Engineer, the evaporation result (from and at 60 degs. Fahr.) per lb. of refuse was very near that

The cost of burning the refuse was 10*d.* per ton for labour and 6*d.* per ton for electrical energy used in the process, taking the current at 3*d.* per unit.

Description.	Result.
Duration of test	8·3 hrs.
Total amount of refuse cremated	32,256 lbs. = 14·4 tons.
Amount of refuse burned per hour	3,885 lbs. = 1·735 tons.
Equivalent in 12 hours	20·82 tons.
Water evaporated per hour	4,876 lbs.
,, ,, ,, from and at 60° Fahr.	5,305 lbs.
,, ,, per lb. of refuse from 55° Fahr. and at 130 lbs. pressure	1·25 lbs.
,, ,, ,, from and at 60°	1·36 lbs.
,, ,, ,, ,, 212°	1·51 lbs.
Average steam pressure from diagram...	130 lbs. per sq. in.
Maximum steam pressure	144 ,, ,,
Minimum ,, ...	90 ,, ,,
Temperature of combustion chamber	2174° Fahr.
,, of flue behind boiler	550° Fahr.
Pressure of air blast	3⅜ inches.

The amount of electrical energy used in the destructor processes was found to be about one-third of the total, and was employed in driving the fan for the forced draught, driving hoisting gear, and actual lifting. The larger proportion is used in driving the fan, whilst that used in hoisting is very small. A 15 cwt. load required 8·5 ampères at 440 volts for 33 seconds, and the height of the lift was 23 feet. This is equivalent to ·045 Board of Trade units per ton lifted; that is, at 3*d.* per unit—about ·135*d.*—or rather more than half a farthing per ton. This figure is exclusive of the friction of the counter shafting driven by the motor, and which is working continuously during the period of hoisting, and takes about 2 ampères to keep it running, except for which the cost of hoisting would be almost insignificant.

The time occupied per lift—*i.e.* 33 seconds—was the same for all loads, so that the lift may be most economically worked when at its full lifting capacity.

The steam pressure, as will be observed above, varied a good deal during the test; but this may be largely controlled after a little continued experience in the working of the furnaces, and is doubtless principally due to the fact of there being only two cells in this plant, not so readily admitting, therefore, of the maintenance of a uniform temperature in the flues as in the case of a larger battery of furnaces.

The temperature rise of the electric motor during the test was 68 degs. Fahr. at the hottest part.

Every precaution was taken to ensure accurate results as to the measurements of refuse and water for the purposes of the test. The water was measured by calculating the contents of tanks between two fixed water levels, the ordinary water meter not being considered sufficiently reliable. The steam-heating pipes in the feed-water tanks were disconnected, and cold water from the town mains was used for the boiler feed so as to ensure accurate results.

The temperatures of the combustion chamber were obtained by the use of "Seger Cones," constructed to melt at a series of fixed temperatures. Four cones were used, two melted, one partially fused, and the fourth remained untouched by

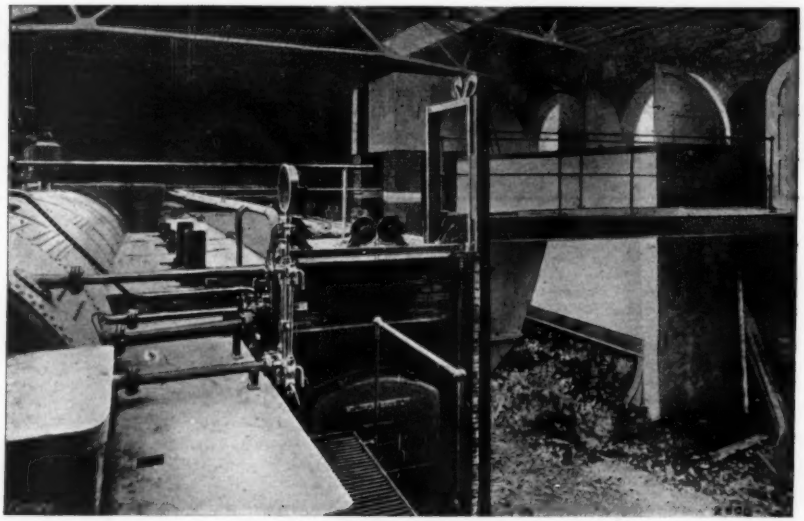


FIG. 13.—GENERAL VIEW OF THE DESTRUCTOR AT NELSON.

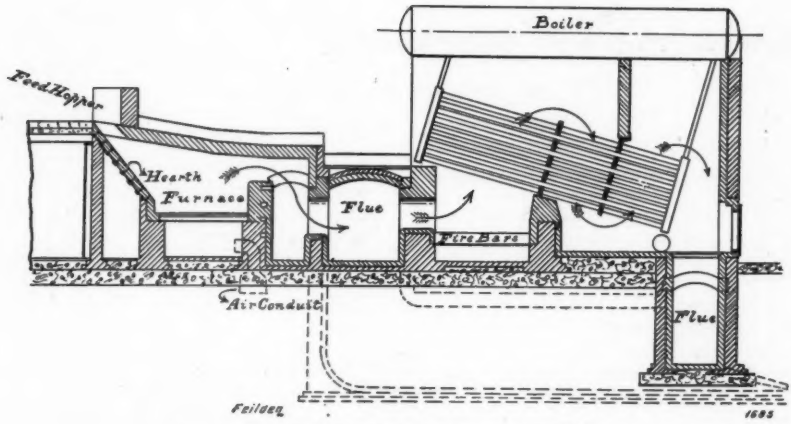


FIG. 14.—A SECTION OF THE BEAMAN AND DEAS DESTRUCTOR.

the heat. A temperature of 2,174 degs. Fahr. was attained in the combustion chamber.

More steam was generated by the destructor boiler than was required to work both sets of plant at the electricity works, and the surplus was allowed to escape into the atmosphere.

(*To be concluded.*)

J. W. Maxwell

Gold-Mining Machinery.

By PHILIP R. BJÖRLING.

(Continued from page 257, Vol. IV.)

CLASSIFIERS AND TROMMELS.

Gold ores should be well dressed, sized, or classified into equal volume, but of different densities. For this purpose revolving screens or sieves are used. They are built in great variety, cylindrical, conical, and polygonal, furnished with perforated metal or wire-cloth. Sizing by screens is almost always conducted on wet material, spraying jets of water being used to carry the small ore through. Revolving screens, placed on a slight incline, are generally used, with a minimum fineness of 8- to 16-mesh. When the sizing of finer particles than 16-mesh is required, hydraulic classifiers are used, because the cost of repairs and renewal of the perforated plates or wire-cloth are too costly. They are seldom used for sizing sand from stamp batteries, although they have been recommended for that purpose by Mr. Rosales.

The objection to the revolving screens is that they require a considerable amount of attention, so that they are not suited for a country where labour is dear; nor have they capacity for treating the large quantity of ore which accumulates at some of the gold mines.

An ordinary revolving screen, as made by Messrs. Robey & Co., Lincoln, is illustrated in Fig. 48. The screens are arranged in series, so that the crushed material passes successively from one to the other, each screen making a distinct separation, which is conveyed by shoots to jigging machines or other concentrating machinery. The screens are parallel cylinders placed at an angle. For coarse classifying they are constructed of steel plates; for fine classifying the cylinders are made with eight flat sides, woven wire being stretched on loose frames. The screens are driven by means of spur-wheels or pulleys, to suit circumstances. For dry screening the trommels are cased with sheet-iron, with dust-tight joints.

The flat-sided trommel is shown in Fig. 49.

The Krom Screen, made by Messrs. Bowes, Scott & Western, is an hexagonal

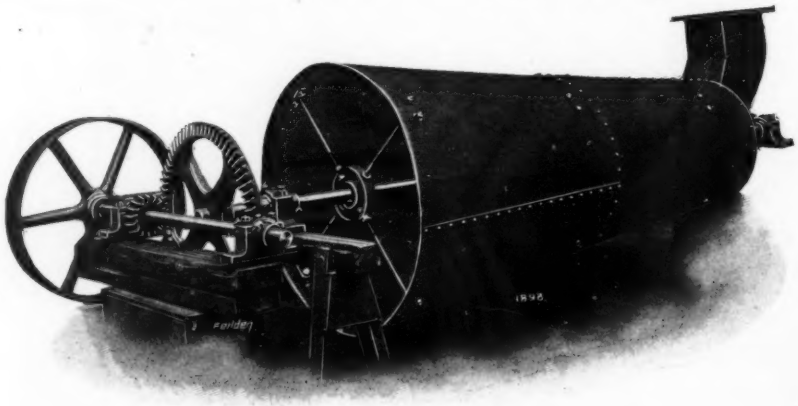


FIG. 48.—REVOLVING SCREEN FOR GOLD ORES, BY ROBEY AND CO., LTD., LINCOLN.

and conical screen of fine sieving. The peculiarity of it is an arrangement of small falling weights, which causes the screen to vibrate and facilitate the passing of very fine ore, and prevents stopping up.

Compound screens are sometimes employed, in which several sizes are combined.

Sometimes the screens are arranged in "tandem" fashion, in a series of three or more; the finer material from one screen passes to a second finer screen, and so on to the required number. The material

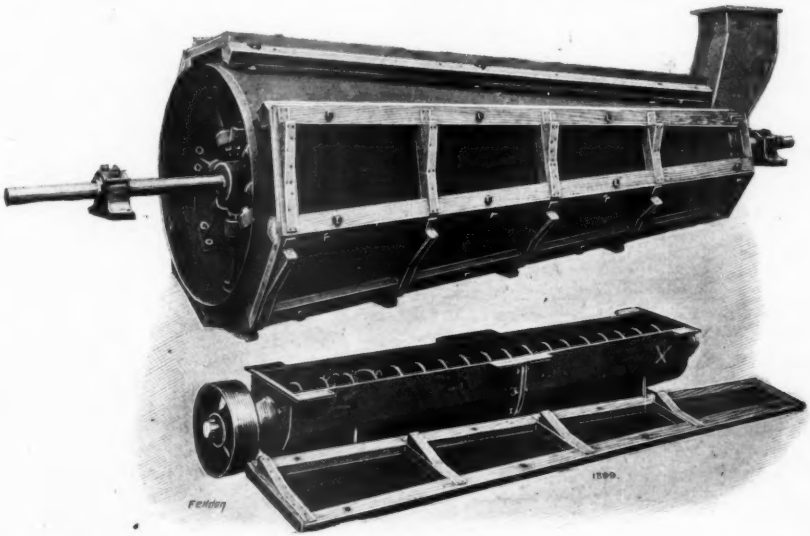


FIG. 49.—FLAT-SIDED TROMMEL FOR GOLD ORES.

remaining on each screen, and afterwards discharged to the proper jig, is thus sized.

The arrangement of screens adopted by Messrs. Calvert, Harris & Co., of Cannon Street, London, is illustrated in Fig. 50. In this case there are six screens, driven from a line of shafting at right angles by bevel gearing. The ore is fed into the uppermost screen *a*; the finest separated matter passes through this screen, the remainder escaping at one end into an iron shoot *g*, which conducts it into the second screen *b*, where the next finished sample is separated, and so on through the series.

JIGS.

The principle on which all well-known jigs work is the tendency of a mixture of ore particles of approximately similar size, but varying in specific gravity, to arrange itself into layers according to gravity when given a motion of adjustment by means of a pulsating column of water. The ordinary type of jig consists of a water-tank divided by a partition above, which does not reach the bottom. On one side of the partition is fixed a horizontal screen on which the sized ore is fed; on the other side a loosely working plunger, operated vertically by a crank or other reciprocating device. The action of this plunger is to cause a regular pulsation of water through the screen, so affecting the particles of ore resting thereon that the heavier particles settle down through the lighter, and either discharge through the screen itself or by an appropriate gate above screen-level, while the lighter particles of rock move on horizontally, discharging over the sides or end of screen-frame. Jigs have usually long wooden tanks with pointed bottoms divided longitudinally by a partition, and

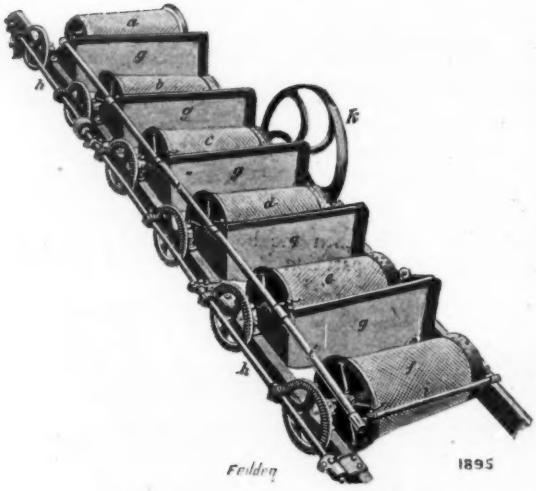


FIG. 50.—ARRANGEMENT OF "TANDEM" SCREENS FOR GOLD ORES.

also laterally into two or more screen spaces discharging one upon another, and with equal corresponding plunger compartments on the opposite side of the longitudinal position. A

THREE-COMPARTMENT HARTZ JIG,

as manufactured by Messrs. Fraser & Chalmers, is illustrated in part sectional elevation Fig. 51, part sectional plan Fig. 52, and transverse section Fig. 53. The eccentric motion is made so that it can be regulated to give a motion of the plunger varying from 0 to 2 ins.; they are lined on the inside with hard wood, fitted with screens and top discharge.

MESSRS. ROBEY & COMPANY'S

Jig illustrated in Fig. 54 is similar to the one last described, having three compartments. It is in this instance made with end delivery and receivers for use at mines where there is a scarcity of water. Ragging gear is applied to all Messrs. Robey's coarse jigs, in order to prevent the accumulation of such stuff as is too light to pass through the bedding, but too heavy to be carried over by the water. The compartments, or, as they are sometimes called, bed-sieves, as a rule vary in number from one to four or five, and depend upon the quality and nature of the stuff treated. These jigs are sometimes made to work by hand.

MESSRS. BOWES, SCOTT & WESTERN'S

Jig is shown in Fig. 55. It differs from the other two examples, inasmuch that the bottom of the hutch is rounded and sometimes made of steel. The plungers are driven by elliptical gearing, instead of the eccentric in the two previously mentioned jigs. The effect of the use of the elliptical wheel is that on the down-stroke the motion begins at a slow speed, increases rapidly and uniformly until the lowest point is reached, then gradually diminishes until the plunger reaches its highest point, the result of these peculiar pulsations being that the heavy ore separates more quickly and perfectly than in the old form of machine, the output being increased considerably. The

CULLOM TWO-COMPARTMENT JIG,

as manufactured by Messrs. Fraser & Chalmers, is well known, especially in America. It is used by many important gold-mining companies, such as Imuris Mines, Ltd., the Butte Reduction Company, and Anaconda Company. The boxes are sometimes made of iron. Fig. 56 is a sectional elevation, Fig. 57 a plan, and Fig. 58 an end view of one of these jigs. The end view shows head and tail, or driving and a following jig, the latter at a slightly lower level than the former.

HYDRAULIC SEPARATORS AND CLASSIFIERS.

Mr. Walter McDermott, in his valuable and practical little book on "Losses in Gold Amalgamation," clearly states the action of the hydraulic classifier :—"It is well known that if a stream of unsized pulp be made to flow through a small

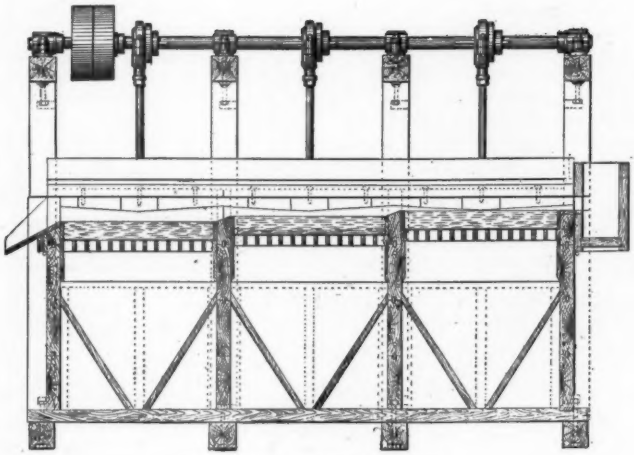


FIG. 51.—PART SECTIONAL ELEVATION.

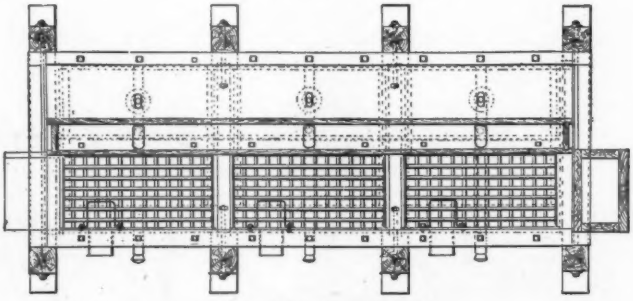


FIG. 52.—PART SECTIONAL PLAN.

FIGS. 51, 52.—THREE-COMPARTMENT HARTZ JIG.

pointed box, with a smaller discharge at the bottom than the inflow, a certain concentration occurs, the lower discharge containing more coarse sand and heavy mineral than the overflow portion. Such a separation is, however, very imperfect, because the lower discharge must contain the slimes and muddy water which constitute the transporting current from the heavier particles."

Lake Superior Trough Separator.

In this separator the pulp flows direct from the coarse screens of the steam stamp through a series of double V-shaped trough classifiers, illustrated in plan Fig. 59 and transverse section Fig. 60. The pulp is carried in the inner trough and clear water in the outer, with openings at intervals between the two, so that the coarse particles drop through, first into the clear water and hence, by stops and openings, are discharged to the different jigs.

The Calumet Classifier.

This classifier received its name from being first used at the Calumet and Hecla Mill; it was originally suggested by Professor Richards, of Boston, and perfected by Mr. Coggin. The water and sand enter at *m*, and undergo successive

washing in each box until the fine sand overflows at *n*. Fig. 61 is an elevation, Fig. 62 a plan, Fig. 63 a transverse section through the line *ZZ*, and Fig. 64 a transverse section through the line *XX*. It consists of four or five boxes *D*, *D*, etc., or depressions in the bottom of a continuous trough. The heaviest sand at once finds its way to the bottom of the box; the wash-water is brought in through a pipe *a* in greater quantity than is sufficient to supply the spigot *E*. No sand therefore can find its way out through *E* that has not weight enough to stem this water-stream. This excess of water also acts by keeping the whole bottom of the box in a boil and turmoil, thus ever pushing up the lighter sands and allowing the heavier to keep near the bottom. The shield *c* plays an important part here by preventing the stream from rising straight up, and thereby confining the turmoil to the bottom of the box, where it belongs. The

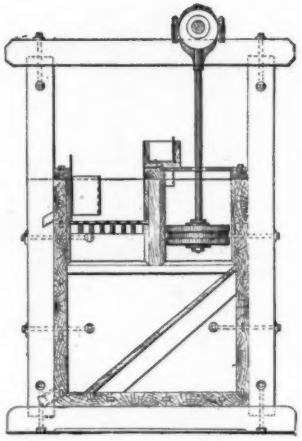


FIG. 53.—TRANSVERSE SECTION. THREE-COMPARTMENT HARTZ JIG.

stop *S* is of importance to prevent the sand from jumping a box altogether, as it

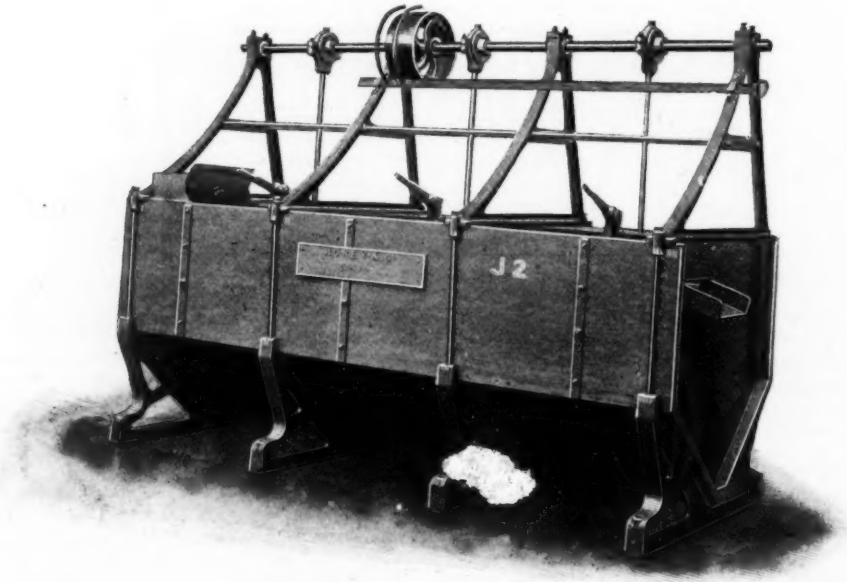


FIG. 54.—JIG BY MESSRS. ROBEY AND CO., LTD.

might do if the current was a little too strong. The several spouts are perfectly under control. A slight increase or decrease in the wash-water will respond with great readiness in the quality of the sand.

The Browne Hydrometric Classifier.

This classifier consists of a series of earthenware cones, as will be seen from Fig. 65, receiving a flow of pulp from copper-plates or settling-pans and distributing it to Frue Vanners in a way that can be closely regulated. The regulation is effected by raising a separate water supply for the classifier under a constant head of 8 or 10 lbs., obtained either by a reducing valve or by using two tanks, one of which overflows into the other, the overflowing tank some 15 to 20 ft. above the classifier furnishing its water supply. This supply goes to each cone through a pipe with cock and dial, and makes a rising current against which the heavier particles of the pulp descend and flow out to the several vanners through a pipe with a cock, the opening of which can be set to secure the desired flow of pulp. The flow of water giving the best result is thus determinable for each cone, and can be adhered to in practice.

Pointers on the dials indicate the amount of water going to each cone. The mineral for the first class goes through the ascending column of water and on to the first vanner, the smaller particles of mineral and gangue being carried up over to the next cone, and so on. The coarse mineral goes to the first vanner, usually of Morse corrugated belt type, capable of handling the surplus water, and so permitting the

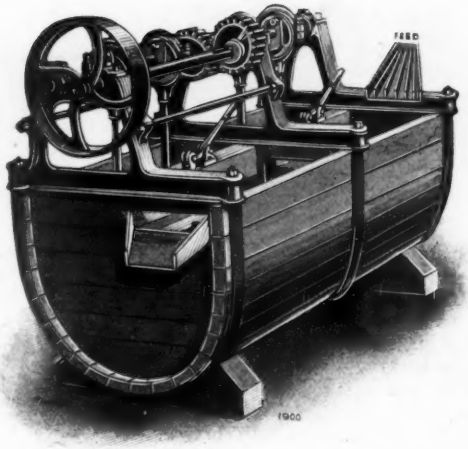


FIG. 55.—JIG BY MESSRS. BOWES, SCOTT AND WESTERN, LTD.

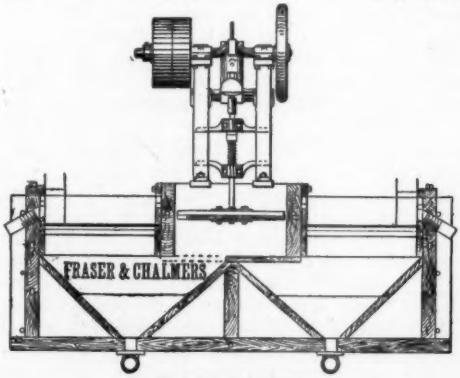


FIG. 56.—SECTIONAL ELEVATION.

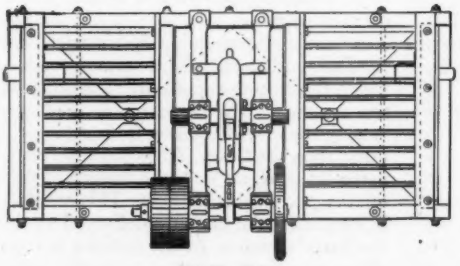


FIG. 57.—PLAN.

TWO-COMPARTMENT JIG, BY MESSRS. FRASER AND CHALMERS, LTD.

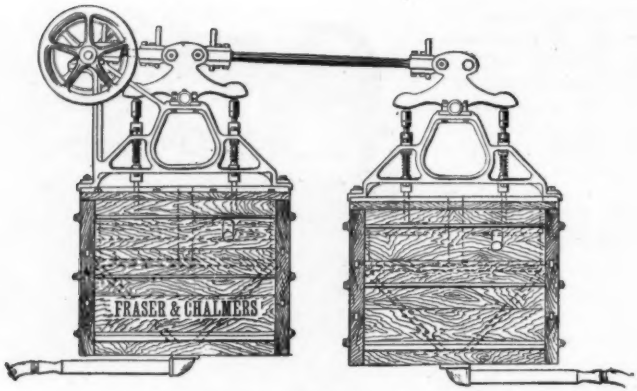
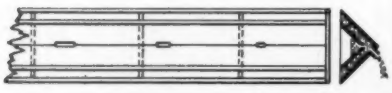


FIG. 58.—END VIEW OF TWO-COMPARTMENT JIG.

remaining vanners to do their work on the slime with no more water than requisite for close result. These other vanners have usually plain belts, 6 ft. wide, run at a lower inclination and a less speed than the corrugated belt on the first machine. These classifiers are manufactured by Messrs. Fraser & Chalmers.

SETTLING BOXES.

The Settling Boxes are used for the purpose of separating slime, and they will, if properly proportioned, give good results and require very little attention. The sides should be at an angle of not less than 50 degs. from the horizontal, as, if made flatter than this, there will be danger of the slime sticking to the sides instead of settling and discharging through the bottom.



FIGS. 59 AND 60.—DETAILS OF LAKE SUPERIOR TROUGH EPARATOR.

FIG. 61.

FIG. 62.

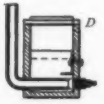


FIG. 63.

FIG. 64.

FIGS. 61, 62, 63 AND 64.—DETAILS OF CALUMET CLASSIFIER.

One of these settling boxes, as manufactured by Messrs. Fraser & Chalmers, is illustrated in sectional elevation Fig. 66, plan Fig. 67, end view Fig. 68, and tranverse section Fig. 69. The pulp to be settled should be delivered across one end of the box, either by means of holes bored in the bottom of the launder or by means of tongues to distribute the stream evenly, as shown in plan Fig. 67. It is very important that a screen sufficiently fine should be used to arrest all chips or foreign matter, which would choke the dis charge opening.

A dividing board should be arranged near the inlet end to cut off all surface current, which would prevent a perfect settling of the material. The discharge is made by cutting the end of the box from 2 to 3 ins. lower than the sides. This should be made perfectly level, so that the water will flow out in a perfectly even sheet. This overflow is caught by the box and delivered to the discharge launder. At the extreme bottom of the box is located the pulp discharge. This consists of a $1\frac{1}{2}$-in or 2-in. nipple,

to which is attached a tee; to the branch of this tee is secured a pipe from 2 ft. to 4 ft. long, carrying a piece of hose with an adjustable valve upon the end. The other opening of the tee can be closed by means of a wood plug or iron cock. By using this method, known as the syphon discharge, a larger opening may be used with less danger of obstruction from chips or heavy slimes. Another advantage of this method of discharge is that less fall is required in the mill site.

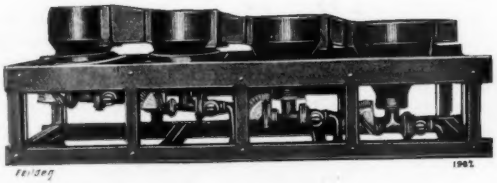


FIG. 65.—BROWNE HYDROMETRIC CLASSIFIER.

Rittinger Percussion Table.

This, like the Stein-Bilharz Vanner, is manufactured by the Humboldt Engineering Works Co., Kalk. This table is built on the Rittinger principle, and is illustrated in Fig. 70. It has side percussion and

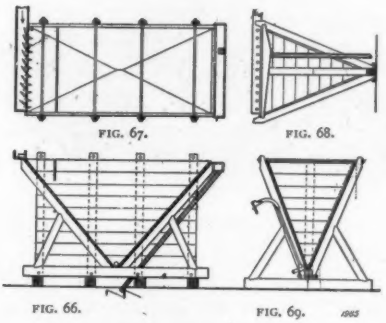


FIG. 67. FIG. 68. FIG. 66. FIG. 69.

FIGS. 66, 67, 68 AND 69.—SETTLING BOXES FOR SEPARATING SLIME.

continuous working, and is very good for high concentration of medium-sized pulp as regards the purity of the products obtained with continuous working. The capacity is not very great and varies considerably, according to the mineral treated, for which reason these tables are usually employed for concentrating valuable or difficult mixed products only.

The pulp to be separated flows on to the head of the table at the right-hand corner. The remaining part of the head is occupied by a clear-water distributor, the quantity of water being adjustable by means of valve handles conveniently placed at the foot of the table.

The side blows cause the heaviest or richest particles to slide from the upper right-hand side to the left-hand side at the foot. Describing a parabolic curve, the middlings follow a similar but flatter curve down the middle of the table, and the tailings flow straight down at once on the right-hand side. The division between the different products is very sharp, and can be easily seen by the difference of colour in the materials separated.

Salzburg Percussion Table.

The Salzburg Percussion Table is used when a specially high concentrator for fine sand is required. It is suitable for valuable ore and for the re-treatment of difficult mixed products, and has the advantage of using much less water than most other slime tables. It works with an end blow, and is intermittent in its working. The stroke is given by a cam on a transverse-shaft at the head of the table, the latter falling back by its own weight, and a buffer, which can be regulated during working from the foot of the table by means of the hand-wheel shown in Fig. 71, strikes against a stiff transverse iron rail. By regulating the projection of the buffer the stroke is altered at will. The inclination of the table can also be varied as required by means of the suspension links and worm and worm-wheel at the foot of the table.

The feed takes place through the hopper and mixing trommel, which delivers on to a spreading-plate. One man can attend to two or more tables at once, and in such cases they are usually made in pairs, driven by a common cam-shaft.

Revolving Buddles

The revolving or round buddles were invented in Cornwall, where they are still used in dressing the tin ores to the exclusion of almost every other concentrator.

There are two distinct varieties of buddles, namely, the convex buddle, in which the ore and water are added at the centre of the machine and flow down over the surface to the periphery; and the concave buddle, in which the pulp is added at the periphery of the machine and flows down to the centre.

In both cases revolving arms, carrying brushes, pass over the surface and stir the deposit as it is being formed, and the spouts distributing the ore are also rotated so as to deliver the pulp evenly. These machines are not continuous in action. After the deposit has accumulated to the depth of a few inches the operation is suspended and the deposit dug out. The "headings," or the materials on the upper 12 or 18 ins. of the inclined surface, are kept separated, and the stuff near the bottom of the slope is called the "tailings." Round buddles are not adapted to obtain a finished product in one operation. The headings and tailings must, as a rule, be subjected to further treatment, and between them is a large quantity of material which differs little from the original ore.

In some cases modifications have been adopted; for instance, riffles containing mercury have been introduced on the inclined surface. Again, in many instances the brushes and ore spouts are made stationary, and the inclined bed is rotated.

The detention of the heavy sand is facilitated by the scrapers being fixed angularly on the arms and intercepting the sand as it flows down from the edge towards the centre, and causing it to return to the rim.

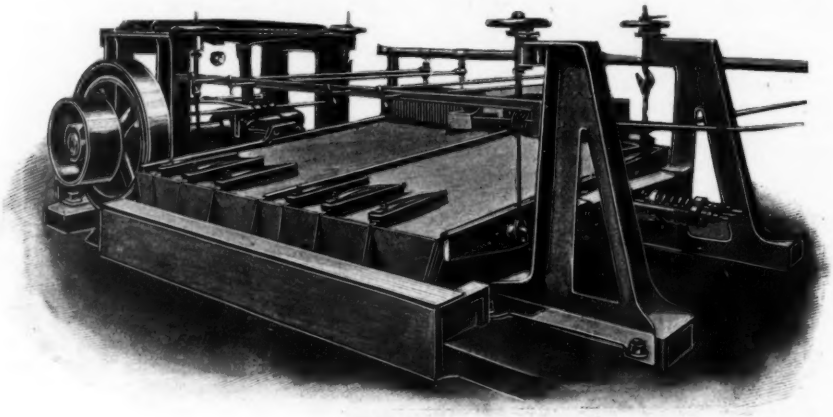


FIG. 70.—RITTINGER PERCUSSION TABLE.

The circular basin may be made of wood, iron, or masonry, and of any convenient size from 12 up to 34 ft. diameter.

The power to drive a 24-ft. buddle may be estimated at from 2 to 4 h.p., the speed of the buddle being five revolutions per minute, water from the stamps to be regulated according to the nature of the sand. A buddle 24 ft. in diameter will efficiently treat from 20 to 30 tons of sand per day, taking it from the batteries.

A slope of about 1 in. per ft. is the usual incline given to the bottom of the

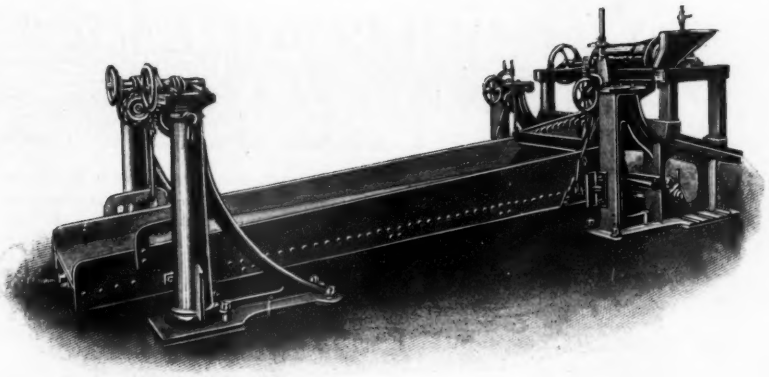


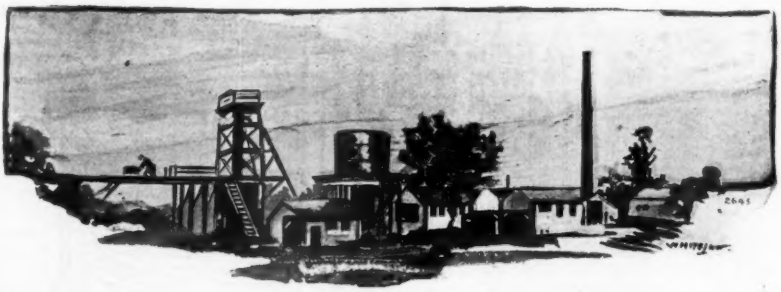
FIG. 71.—SALZBURG PERCUSSION TABLE.

basin. The angle at which the scrapers are set with the arms is about 18 degs. from the right angle.

The scrapers are sometimes made of india-rubber.

(To be concluded.)

Philip R. Björling

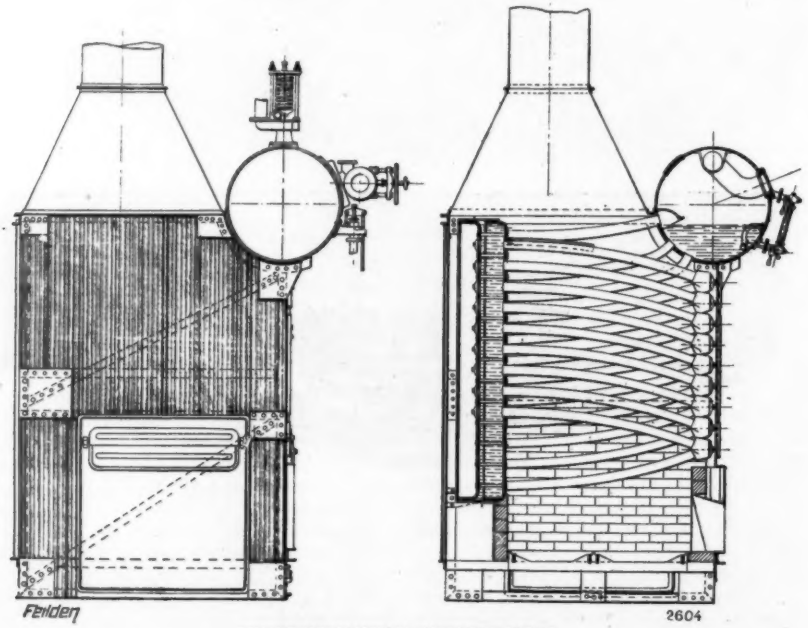


MACHINERY APPLIANCES AND PROCESSES.

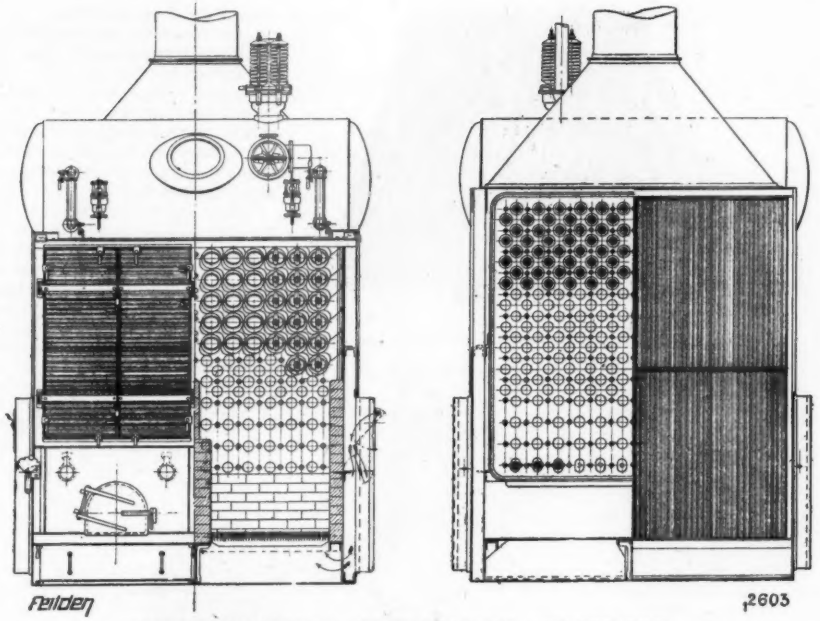
"Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

THE THORNYCRORT-MARSHALL WATER-TUBE BOILER.

THOSE who were anxious for a large-tube type of British water-tube boiler have not had long to wait, and it will be satisfactory to them to know that two eminent firms have put their ideas together for the purpose of evolving a boiler which should suit the purposes of the Admiralty and possibly a considerable number of ships in the mercantile marine. The firms who have joined for the above purpose are Messrs. J. I. Thornycroft & Co., of Chiswick, and Messrs. Hawthorn, Leslie & Co., of Newcastle-on-Tyne. Those who expected much from the more eminent of the British firms producing a boiler which would not be second to anything of the kind



THORNYCROFT-MARSHALL WATER-TUBE BOILER.
SIDE SECTIONAL ELEVATION, SHOWING TUBES IN POSITION AND STRENGTHENING STAYS.



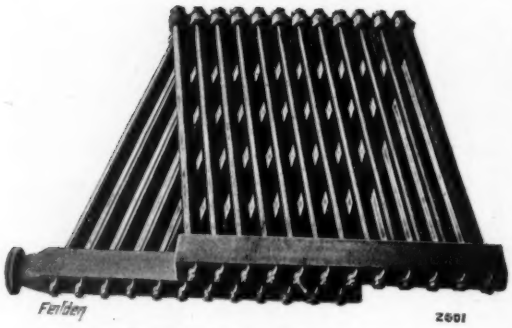
FRONT SECTIONAL ELEVATION. THORNYCROFT-MARSHALL WATER-TUBE BOILER.

either in the United States or on the Continent will not be disappointed. The boiler in question has several new and marked features which stamp it as original and improved in its design.

It will be seen from the illustrations which we give that the boiler consists in the usual steam separating drum at the top, of a flat water tank placed vertically at the back, and a number of tubes expanded into the water-box and joined at the front in pairs by knee joints. The water tank at the back is a novel feature in water-tube boilers and is of considerable dimensions and is 8 ins. wide inside. To strengthen the flat sides stays are screwed in as shown in the sectional figure 1. To enable a breakage to be detected the stays are bored. The water tubes are bent to a radius of 15 ft. 8½ ins.; they are 3¼ ins. outside diameter and ·176 ins. thick in the metal, and they can be seen through and examined from both ends. The steam separator is 3 ft. diameter inside.

The feed-water is pumped into the separator and descends through the water-tubes connected to the separating drum to the water tank at the back. As the tubes are heated the water ascends the lower tube of any pair, passes the joint, and returns to the tank by the higher tube of any pair. The circulation of the water is thus from the tank through the lower tubes of all the pairs to the front, and back through the higher tubes of all the pairs to the tank. It will thus be noticed that the water does not circulate through the separator, but is confined within the tank and tubes. This arrangement has many advantages. The circulation will be rapid where quick motion is wanted, namely, in the lower tubes near the fire. The steam-too, as it is generated, will flow into the tank and reach the separating drum in a much drier condition than when the water has to go through the separating drum in its path of circulation. Of course, water does really flow with the steam into the steam drum, but in comparatively small quantities, and it flows down with the feed-water through the down-comer pipes to the tank.

It is not an express type of water-tube boiler, because the tubes, large and small, have not a great inclination, and in the progress through them the steam has to separate itself from the water. The head of water which produces the circulation is small, and the tubes being large the water



ARRANGEMENT OF TUBES IN THORNYCROFT-MARSHALL WATER-TUBE BOILER.

and steam does not move through in pulsations. In this boiler there is little chance of the reversal of circulation.

Opposite each tube mouth is a small door at the back of the tank, and the junction boxes also have a cover on the front. These covers allow the tubes to be inspected when that is considered desirable. Both ends of each tube can therefore be exposed, and it can be examined from end to end.

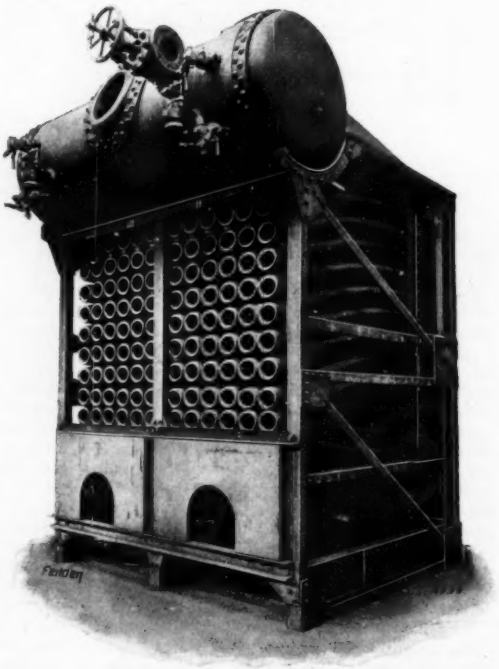
To properly retard the gases the tubes are made to cross each other. It will be seen also that the tubes in the lower portion are more widely spaced, and this also gives the gases a better chance of being fully consumed before they go very far.

The boiler has been working for some time at Messrs. Thornycrofts' at Chiswick, and its trials show that it complies with the Admiralty conditions. It has not, however, been tried afloat, and, as was shown in the late discussion at the Institute of Naval Architects, a boiler cannot be pronounced upon until it has been tried under full sea-going conditions.

Designs have been got out for the fitting of this type of boiler in a sloop of war. The total heating surface of the installation will be 4,800 sq. ft., and the grate surface 130 sq. ft. The total weight of the installation will be 69 tons.

The boiler at Chiswick has 1,200 sq. ft. of heating surface and 32½ sq. ft. of grate area. The total weight of the boiler, with casing, furnaces, fittings, brickwork, and mountings, with water in a condition for working, is 17¼ tons. There are 252 solid drawn steel tubes. The floor space covered is 73 sq. ft., and the evaporation with natural draught is 7,000 lbs. from and at 212 degs. per hour.

There is another design for a sectional boiler, and one boiler has been constructed at Messrs. Hawthorn, Leslie & Co.'s place on the Tyne. This design has been got out for large installations whose sections can be removed for cleaning and repairing without removing the whole boiler. In this arrangement the water-box is replaced by a series of headers. One set of pairs of tubes have ends expanded into one header, and the other ends of the

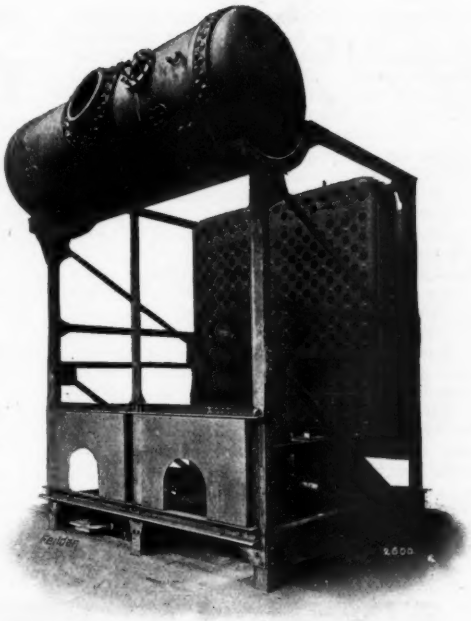


THORNYCROFT-MARSHALL WATER-TUBE BOILER. SHOWING TUBES IN POSITION AND WATER TANK AT BACK.

pairs expanded into the next header. At the bottom there is a tube containing the feed-water communicating with the headers, and there are down corner tubes from the separator to the feed distributor to enable circulation to be completed.

The design of this boiler is original and very promising, and we shall look forward to the result of its further trials on land and sea with much interest.

Since the above was written we have been favoured with the reports of trials made on shore — by the Admiralty engineer who conducted the trials — and sent to the Controller of the Admiralty. The trials were made with the non-sectional type. The boiler has 32½ sq. ft. of grate area, 1200 sq. ft. of heating surface, the tubes are 3½ ins. external diameter; it occupies a floor-space 8 ft. long by 9 ft. 9 ins. broad, and the height from the floor-plates to the top of the barrel is 12 ft. 8 ins. It is designed to supply the steam for 350 i.h.p. with triple expansion and auxiliaries when burning 18 to 20 lbs. of bunker coal per sq. ft. of grate per hour. It has two furnaces, each 5 ft. long by 3 ft. 3 ins. wide, which are easily fired. The quantity of water in the boiler is 207 lbs. per sq. ft. of grate, or 5·6 lbs. per sq. ft. of heating-surface. The tubes, which are hot drawn and ungalvanised, are easily swept from the front. The whole boiler may be retubed without disturbing the water-vessels of the boiler or breaking of steam-pipe joints, and it is probable that each and every tube may be replaced by a new one without destruction



THORNYCROFT-MARSHALL WATER-TUBE BOILER. TUBES REMOVED, SHOWING WATER TANK AT BACK.

RECORD OF TRIALS.

THORNYCROFT-MARSHALL WATER-TUBE BOILER (NON-SECTIONAL TYPE). GRATE 32·5 SQ. FT, HEATING SURFACE 1,200 SQ. FT.

Date.	Strain-pressure.	Air-pressure at foot of furnace.	Coal burned per sq. ft. of grate.	Temperature in uptake.	Feed-water temperature.	Per sq. ft. heating surface.	Per lb. of coal from and at 212°.
	lbs.	in.	lbs.				
11 March, 1901 ...	180	·15	18	not taken	44°	4·24	10·671
12 ,, ,, ...	181½	·25	24	—	44°	5·40	10·183
13 ,, ,, ...	185	·28	30	685°	44°	5·93	8·958
15 ,, ,, ...	185	·20	12	386°	44°	2·00	10·966
16 ,, ,, ...	185	·21	18	450°	44°	3·66	9·200
22 ,, ,, ...	204	·20	18	514°	44°	3·93	9·919
23 ,, ,, ...	208	·20	21	544°	43°	4·60	9·907
30 ,, ,, ...	211	·18	20	557°	44½°	4·56	10·318

Coal: Hand-picked Welsh on trials, 11th, 12th, 13th, 15th, 22nd.

Nixon's Navigation, 30th.

⅔ Welsh and ⅓ Hartley, 23rd.

Welsh dust, 16th.

Steam blast was used on trials of 12th, 13th, and 16th.

or disturbance of any of the other tubes of the boiler. The water was very steady on all trials; the flames kept alight till near the upper tubes. Five trials were run with chimney draught only; three with forced draught; 30 lbs. of coal could be burned per sq. ft. of grate with less than $\frac{3}{10}$ in. of air pressure. Five of these trials were with Welsh coal of "cricket-ball size," one with coal dust from the hinder side of a gravel sifter of $\frac{1}{2}$-in. mesh; one with Nixon's Navigation Commercial bunker coal, and one with Welsh $\frac{3}{4}$, North Country $\frac{1}{4}$. On this last the smoke was much less than when this mixture was burned at lower rates in His Majesty's ships. The temperature of the uptake was comparatively low; the plates of this were painted black, and the paint is still on them in good condition. When burning up to 21 lbs. per sq. ft. of grate per hour 97 per cent. of the steam passed through the main stop-valve, and was available for propulsion. In trial No. 6 the steam was raised to 220 lbs., blowing off pressure from water of 42 degs. Fahr. in 51 minutes.

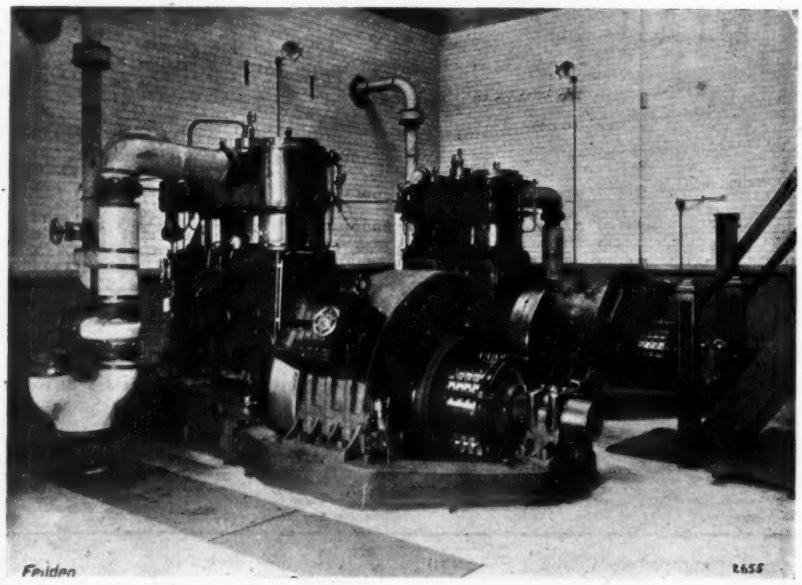
BIRKENHEAD ELECTRIC TRAMWAYS.

THE illustration below represents two of Messrs. Ernest Scott & Mountain's enclosed high-speed steam dynamos which they have supplied in connection with the Electric Tramways for Birkenhead. These have been installed at the sub-station which the Corporation have recently erected in New Chester Road adjoining the destructor buildings, and are to supply the current for the southern portion of the borough.

The plant consists of two of Messrs. Scott and Mountain's enclosed compound, central valve, self-lubricating high-speed steam engines, each of 240 i.h.p., and having cylinders of the following dimensions:—

Diameter of h.p. cylinder, 11¼ ins.; diameter of l.p. cylinder, 20 ins.; stroke 10 ins.; revolutions 360.

Steam pressure, 140 lbs., condensing with a vacuum of 24". The engines are each fitted with a governor of throttling type fitted with byepass enabling the steam to enter the low-pressure cylinder direct in the event of a sudden overload being thrown on the engine



NEW HIGH-SPEED ENGINES AND DYNAMOS FOR BIRKENHEAD ELECTRIC TRAMWAYS.

Steam separators, with connecting pipes and cocks, are also fitted, as well as indicator gear and the usual accessories.

The engine is fitted upon a combination bedplate of cast-iron which is arranged to take the generators.

The generators are of Messrs. Scott & Mountain's four pole type, with slotted drum armatures, each giving an output of 273 ampères at 550 volts.

These dynamos, when running as shunt machines with all adjusting resistance of the magnets cut out, will be capable of giving an e.m.f. of 600 volts at the normal speed. Each dynamo is complete, with two shunt breaking switches and resistances, two regulating switches and resistances, and two diverting series switches for adjusting the strength of the compounding coils on the machines.

Messrs. Scott & Mountain have also just completed four similar sets for the Darlington Corporation, equal to 400 h.p., three sets for Worksop Corporation, three sets for Worthing Corporation, and three sets for the Hill of Howth Electric Railway in Ireland.

We hope later on to give notices of these plants, which we have no doubt will be of interest to all our readers.

NEW RADIAL DRILLING MACHINE.

THIS machine has been specially designed with a view to handiness in work, and is being manufactured by Messrs. Ward, Haggas & Smith of Keighley. It consists of strong table of bed with T slots on the top and down the front side. Upon one end of the bed is firmly bolted the pillar, on to which is carefully fitted by grinding the external pillar, upon which slides the arm, the same being carefully ground to fit, and is split up the back and provided with locking bolts. On the arm slides the drill head, adjustable by rack and pinion and hand wheel. It is fitted with steel spindle working in large cast-iron socket with conical bearings, provided with check nuts to take up wear. It has self-acting and hand-feed motions by means of the three speed cone and rack and pinion, is provided with ball bearing to take the pressure of the cut, and is balanced by means of weight sliding down a rod at the back of the drill carriage. It is also provided with quick down-setting and withdrawing motion, the self-acting gear being disengaged by means of eccentric socket, which at the same time that it disengages the self-acting feed, brings into gear two spur wheels, which gear direct into the rack pinion shaft, by means of which one revolution of the hand wheel on feed shaft raises or lowers the spindle 4 inches, thereby dispensing with any unsightly levers, &c., as well as being very handy. The spindle can be stopped, started and reversed by means of clutch on drill head without interfering with the overhead motion. This clutch when thrown out also disengages the feed motion (which is not the case with many machines), thereby preventing breakages of drills, &c. The arm can be turned through a complete circle by means of worm and worm wheel, and is raised and lowered by power by means of reversing gear at the top of the pillar, and screw; the handle for operating same being within easy reach of the attendant. The machines are driven by cone pulleys, through suitable spur gear, which is so arranged that one movement of the lever puts in or out of gear the double purchase, thereby saving considerable time in changing, as there is no spanner to look for and no screw to loosen, the direct drive being by means of expanding clutch in the front wheel. There is a final purchase on the drill head to reduce torsion in the driving shafts. The machine is complete, with overhead motion and all necessary screw keys.

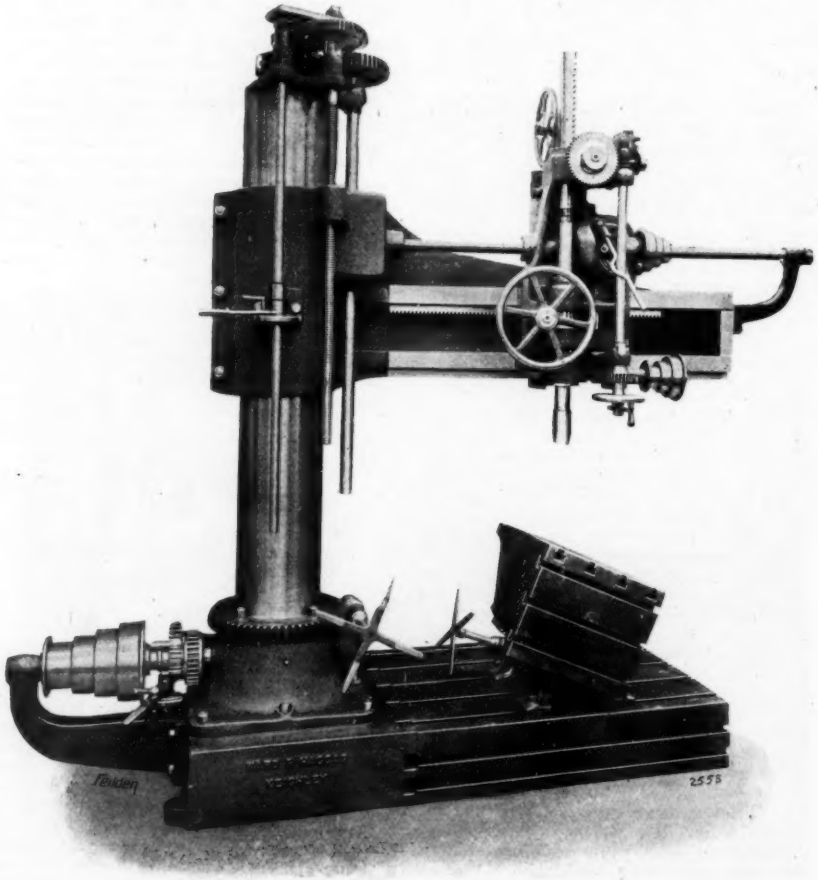
If necessary the machine, which is being turned out in four different sizes, is also provided with a small loose table for light work, which is made to swivel at an angle up to 90 degs. by means of worm and worm wheel, and is indexed to show the angle at which it is tilted. It is made with T slots on top and down front side for bolting the article whilst being operated upon.

A HIGHLY-EFFECTIVE BOILER AND PIPE COVERING.

ASBESTOS coverings for boilers, pipes and cylinders are no novelty, and both the non-conductive quality and durability of this material have long since been recognised and utilised for reducing the deleterious effect of the very high temperatures met with in the various branches of modern steam engineering. Not all coverings, however, into which asbestos enters as insulating material are of equal efficiency, and much seems to depend upon a judicious combination with other substances when the best effect with the greatest economy is the aim to be attained.

A small initial expenditure is most alluring to some manufacturers, but the reduction of first cost has often heavily to be paid for in the end, since it is obtained only at the cost of durability. In steam engineering, as well as in most other undertakings, the most expensive—to use a paradox—is often the cheapest; and this should be borne in mind also when selecting boiler and pipe covering.

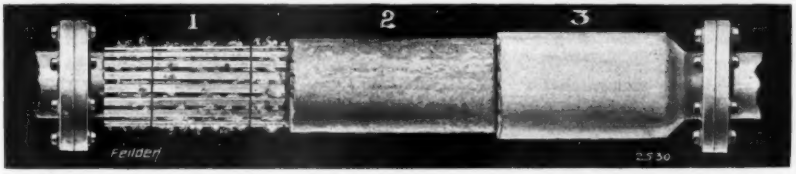
Messrs. Emmott & Co., of Victoria Works, Stalybridge (near Manchester), some years ago acquired, and are the sole owners of, the rights of Mr. George Waterhouse's non-conducting composition, including his patented "Excelsior" Asbestos Compound and improvements for the application of silicate cotton, together with the plant specially laid down for the manufacture of this compound. By careful experimentation and due regard to practical tests of sufficient duration to permit a definite conclusion to be arrived at, they claim to have succeeded in manufacturing a covering which reduces the extreme temperatures occurring in very high-pressure steam boilers and piping to less than half that still to be met with even in boilers, &c., working at ordinary pressure where other coverings are in use. The way in which



NEW RADIAL DRILLING MACHINE BY MESSRS. WARD, HAGGAS AND SMITH, KEIGHLEY.

their combination covering is applied to pipes is shown below, where three portions of a pipe are represented, each of them representing one of the three successive stages of the work. Portion 1 shows the prepared silicate cotton being held in position on the pipe by laths; portion 2 shows the first coat, or "binding," of the patented "Excelsior" Asbestos Compound; and portion 3 shows the finished appearance of the pipe after having obtained its final coat. The "Excelsior" Compound possesses a much better binding quality than ordinary asbestos or the asbestos compositions. The silicate cotton shown in portion 1 is put on 2 in. thick on large piping, while a thickness of 1½ in. suffices for the smaller sizes.

For covering boilers with the compound, two methods are used. One of these consists in covering the boiler with a layer 3 in. in thickness of the best quality of specially prepared silicate cotton, and afterwards "binding" it over with two layers of the "Excelsior" Compound; and one final ditto of what Messrs. Emmott & Co. call "Excelsior" Asbestos Compound Finishing Material. The second method is to cover the boiler with one coat of prepared asbestos, and to put over this a thinner layer, of about 1 in. thickness, of the best quality of specially prepared silicate cotton, binding over the whole with two coats and a finishing layer of the Patent Asbestos Compound, protected by a layer of varnish or paint as desired. The initial expenditure in using either of the two methods described is, of course, slightly higher than when the ordinary compositions in the market are used; and where such expenditure is a serious drawback, a cover of the "Excelsior" Asbestos Compound alone may be used and still give satisfactory results. As above stated, however, initial expenditure is no ultimate test of economy. As regards the latter, not only high efficiency but also durability enter into the calculation as important factors. It is claimed by the makers that its efficiency is such as to secure an extra economy of from 15 to 25 per cent. when compared with that of the older types of boiler and pipe covering.



NEW TYPE OF ASBESTOS COVERING FOR BOILERS AND PIPES.

JOY'S ASSISTANT CYLINDER

THE valves of marine engines are sometimes of enormous dimensions, and great forces are called into play to overcome the friction in moving them and to support their weight and deal with their inertia. Mr. Joy, to take the friction off the eccentrics, introduced a steam cylinder to do the work of moving the valves and thus release the eccentrics.

In the ordinary form the Joy Assistant Cylinder has two stop valves, each taking high-pressure steam, one admitting it to the upper side of the piston and the other to the lower side, so that there is high-pressure steam on both sides. The ports for the admission of the steam to either end of the cylinder are in the piston itself, which passes over the ports in the cylinder walls. Under such conditions a long cylinder is required, being from three times the travel of the valve for short strokes (about 4½ ins.) to two-and-a-quarter times the travel for longer strokes (about 12 ins.). In some cases this length makes it impossible of application, owing to the limited head room under the armoured deck.

The new design of the cylinder which we illustrate overcomes this difficulty very effectively. The steam is also used under the compound system of expansion, and there is a further economy due to that. In this high-pressure steam is admitted to the under side of the piston only, and after expanding there is carried up by the piston and admitted at a reduced pressure to form the cushion at the top. Only one stop-valve is required for steam admission. The two ports are taken out of the piston and one only put in the spindle. By reducing the diameter of the spindle at a given point a

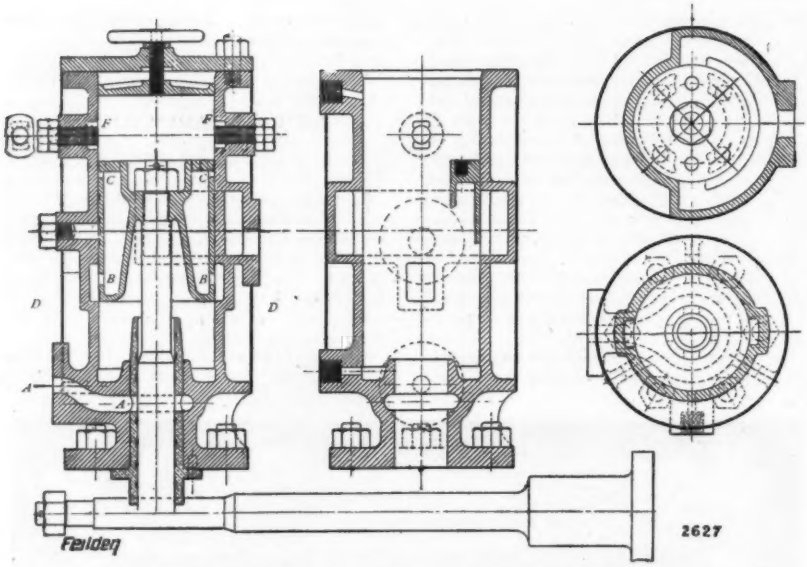


FIG. 1.—DETAILS OF JOY'S ASSISTANT CYLINDER FOR MARINE ENGINES.

lip is formed which acts as the steam edge of the admission valve, while the outside edge of the piston still acts as the exhaust as before.

In the drawing *A* is the admission of the live steam; as the piston and the rod get towards the bottom of the stroke steam is admitted through the port *A* into the annular space between the rod and the brass bush, and so into the bottom of the cylinder, forming a cushion for the downward stroke of the valve and a driving force for the upward stroke.

The piston is hollow, and has in its sides two small ports, *B B* and *C C*, one on each side, so as to keep it in balance. In the walls of the cylinder are the small recesses *D D* and *F F*; as the piston rises, steam is cut off by the lip on the rod, expands, and is then admitted just before exhaust into the recesses *D D*, and through them into the body of the piston through the ports *B B*. The steam is then carried up by the piston until it escapes through the ports *C C* into the recesses *F F*, and so into the top of the cylinder, forming a cushion for the rising stroke, and starts the valve on its downward stroke. Shortly after it is released into the exhaust by the upper edges of the piston. It is thus a self-contained automatic engine controlled by the valve gear, and effectually drives the valve. The valve gear is greatly relieved of work; in fact, it has little more

FIG. 2.—DIAGRAMS TAKEN ON BOARD SS. "SULTANA," FITTED WITH JOY'S ASSISTANT CYLINDERS.

to do than control the assistant cylinder. It will be seen that the mechanism has been greatly simplified, for there is nothing now to get out of order, or require adjustment, except the one stop-valve. This valve is set to the requirements of the valve gear by trial, and only so much steam as is required to enable the valve gear to run smoothly and quietly is admitted.

The steamer *Sultana*, which plies between London and Venice, has had one of the new type of cylinders fitted, with most satisfactory results. Before this was done, the eccentric liners showed a wear of $\frac{5}{16}$ths of an inch for the round voyage ; since they have been fitted the wear has been reduced to the thickness of a tin liner. After the last voyage the gear was in such good condition that it will not require to be touched or overhauled in any way. Formerly water had to be run on the eccentrics, which caused a good deal of scoring action, but no water is required now, and the surfaces of the eccentric are quite good.

It only remains to indicate the quantity of steam which is required to drive the valve separately in this way. On the large London, Brighton, and South Coast passenger screw steamer *Sussex*, which plies between Newhaven and Dieppe, indicator cards were taken of the work done in the cylinders. From these it appeared that some 11 h.p. was being taken to work them directly from the boilers. The advantage, of course, lies in relieving the valve gear. The work of driving the valves would require to be done in any case, and it would be of the same amount, but to do it directly obviates the wear of the eccentrics and links, and reduces the great amount of friction which would otherwise be called into play at these wearing surfaces.

AN IMPROVED LATHE FOR "FACING" THE FLANGES OF CAST-IRON PIPES.

THE Lathe shewn in illustration was designed specially for machining the flanges of cast-iron pipes up to 36 diameter, both ends at one time. One of the largest pipe-makers in the kingdom were very much behind with their machining or "facing," and as they had very large numbers of pipes on order this was becoming a serious matter. It was found impossible with the old type of lathe to "face" more than four pipes per day, so this firm ordered a special lathe for this class of work only. The result has been eminently satisfactory, as with

IMPROVED TYPE OF FACING LATHE.

this new machine it is possible to turn out fifteen pipes per day with greater ease than they could four under the old system! Two massive headstocks, each provided with a facing arm, are mounted on a substantial bed, these headstocks are moved nearer to each other or further apart (so as to suit pipes of various lengths) by means of rack and pinion, the bed is provided with two vee rests and packing pieces to suit all diameters of pipes, each headstock is driven independently, and when operating on pipe flanges are run in opposite directions, so as to prevent any lifting tendency on the part of the pipe. A side bracket is also provided to enable elbow pipes to be easily dealt with. The height of centres is 20" and the bed sufficiently long to admit pipes 14 ft. long. The nett weight of this lathe is 11 tons.

THE SS. "CELTIC."

THE largest ship afloat, which forms the subject of our supplement plate this month, was launched on the 4th April from Messrs. Harland & Wolff's, Queen's Island yard. She is 700 ft. in length, beam 75 ft., depth 49 ft., and displacement at a draught of 36ft. 6 ins., is 37,700 tons. She is nearly 20,880 tons gross and 13,650 tons net register. It has been popularly believed that the *Great Eastern* was by far the greatest vessel, but the displacement of the *Celtic* is 10,300 tons greater than Brunel's mammoth ship. The *Oceanic* was the largest up to the launching of the *Celtic*, and although the former is 5 ft. 6 ins. longer than the latter the *Celtic* has 7 ft. more beam. The *Celtic* has nine decks; the lower orlop, orlop, lower, middle, upper, bridge, upper bridge, boat, and sun decks. Five of them are full length. She is built with cellular double bottoms, and has a flat bar keel riveted to the angle bars of the vertical keel and to the garboard strakes of the shell plating. She has also bilge keels extending for 250 ft., and the bilge strake is doubled. The sheer strake, and the next but one, and also the upper deck stringers, are doubled. The main structural decks have a beam on every frame. The propellers are carried in the same way as those of the *Oceanic*, and the rudder is made up of cast-steel sections bolted together. Harland & Wolff's quadruple expansion engines of the balanced type are fitted into her. The cylinders are 33 ins., 47½ ins., 68½ ins., and 98 ins. diameter, with 5 ft. 3 ins. stroke. Eight doubled-ended boilers, 15 ft. 9 ins. diameter, and 19 ft. 6 ins. long, will supply the steam at 210 lbs. pressure to the engines. As it took some three months to launch the *Great Eastern*, it is interesting to know the manner in which the *Celtic* was launched. The cables used were 3⅝ ins. diameter, the largest ever made for a ship. The trigger to hold the vessel in check was held in the locking position, due to a hydraulic pressure of 445 tons. The weight of the hull was 15,000 tons. The trigger was pulled at 10min. 17 sec. a.m. and in 55 secs. she was completely afloat, and brought to rest by her anchors in 26 secs. She was then towed into the Alexandra dock for her machinery. There is accommodation for 2,859 passengers, 347 first class, 160 second class, and 2,352 third class. The first grade accommodation provides single berthed rooms. The first-class passengers' rooms are placed on the upper, the bridge, upper bridge, and boat decks; the second class aft on the upper and bridge decks; and the third class on the upper, middle, and lower decks. Married couples and single women will be berthed in the after end, single men in forward end. The officers' rooms are on the upper bridge deck. There is a deck crew of 64, engine room and stokehold of 92 and 179 stewards.

The principal dimensions of the most important vessels afloat are given below.

Vessel	Length	Breadth	Depth	Gross tons
Great Eastern	691	82 ft. 8 ins.	48·4	18,915
Paris	560	63 ft. 2 ins.	39·2	10,500
Campania ...	620	65 ft.	43	12,950
Oceanic	705·6	68 ft.	49	17,274
Deutschland ...	686	67 ft.	40·4	15,500
Celtic	700	75 ft.	49	20,880

SOME LESSONS OF THE RAILWAY ACCIDENT AT SLOUGH.

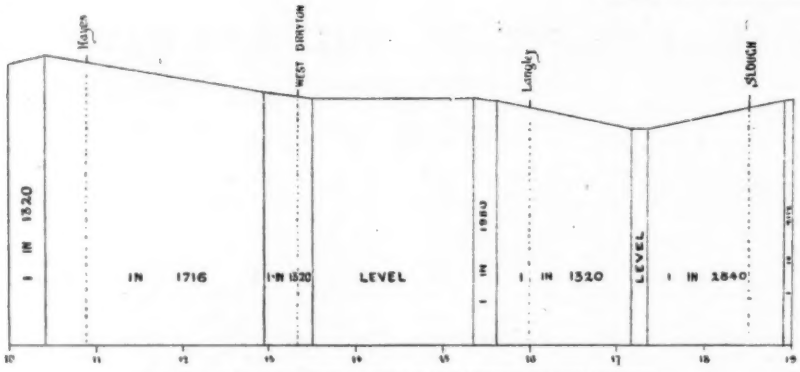
I HAVE before me the Report to the Board of Trade of Lt.-Col. Yorke on the accident which occurred on June 8th last at Slough Station on the Great Western Railway. There are some aspects of this deplorable accident which merit serious consideration by those responsible for the safe working of our railways, and to which I now propose to draw the attention of our readers.

The main features of this accident are probably still within the recollection of most people. The train leaving Paddington for Windsor at 1.5 p.m. was late in getting away, owing to a sudden influx of passengers on their way to attend the Windsor races. While tickets were being collected at Slough station this train was run into from behind by the 1.15 p.m. Falmouth express, the driver of which overran both signals at the Dolphin intermediate box, and also the Slough East distant signal.

No exception can be taken to the conclusion arrived at by the Board of Trade Inspector as to the primary cause of the accident. I entirely agree with his dictum, and no more need be said about the matter. There is, however, an omission in the report which is so remarkable that one is fain to conclude there must be some strong reason to account for it. We have here the case of a driver being suddenly confronted with danger ahead of him, and in spite of the fact that the powerful brake at his command was fully applied several hundred yards before reaching Slough station, he was unable to pull up his train in time to avoid a collision. The question is therefore: did the automatic vacuum brake with which the train was fitted throughout achieve all that could reasonably be expected of it under the circumstances? This question does not appear to have presented itself to Col. Yorke; at any rate there is no mention of it whatever from beginning to end of his report. Let us look at the facts. We have first the evidence of Mr. Armstrong, the District Locomotive Superintendent at Paddington, who states that he examined the brake apparatus shortly afterwards, and, except for damage caused as a result of the accident, found it to be in good working order. Then we are told that the head guard tested the brake before leaving Paddington, and that during the journey down he noted the pressure, as indicated by the gauge in his van, to be 25 inches; this is also corroborated by the driver. We may take it, therefore, that everything was in good working order. Now as to the speed of the train there is, of course, no direct evidence; the driver estimates it at 52 miles an hour, the guard at 50 or 60; the fireman agrees with his driver. For myself, I believe these estimates are too low. As will be seen from the gradient profile the line falls gradually from mile-post 10½, though the gradient is very slight. The train in question, namely, the Falmouth express, is not one of the best trains, and the booked speed to the first stop at Reading is distinctly moderate (about 48 miles an hour). I have myself rarely passed through Slough station at less than 60 miles an hour, and when timing the crack Great Western expresses, have frequently exceeded 67. Always the speed has reached 60 after passing the 15th mile-post. I think, therefore, we shall be very near the actual mark if we assume a speed of 62 miles an hour at the moment when the brake was applied. The question which remains to be answered is: where was the train when fireman Cann applied the brake with full force? The evidence on this important point is conflicting. The fireman, who should be in the best position to offer an opinion, gives it in the following words:—

> "When I applied the vacuum brake I do not think we had actually passed under the bridge. . . . I saw the home signal by looking under the bridge; it was then at danger. I believe that I shut off steam before we passed under the bridge."

The head guard, however, states that he thinks they were between the bridge and the home signal, and that the engine must have been close to the home signal. As the inspector throws no doubt upon the evidence offered by the fireman, and as he could have no possible reason for stating anything but the bare truth, I prefer to accept his estimate. In any case there can be no doubt that the brake was fully applied before this signal was passed, and we may take it, therefore, that the minimum distance available for stopping the train was 227 yds. The bridge itself is, however, 594 yds. from the point of collision, and we shall therefore be very near the mark if



G. W. R. MAIN LINE GRADIENT PROFILE IN THE VICINITY OF THE ACCIDENT.

we conclude that the actual margin available was 500 yds.—all of it on a slightly rising gradient; this, at any rate, is the only possible conclusion if we are to accept the statement of the fireman. The various points in question are clearly marked on the gradient profile, and it is somewhat remarkable that no plan or profile was drawn up with the inspector's report, an omission which is surprising, to say the least, in a matter of such importance. It should be mentioned that the total weight of engine, tender, and train was 291½ tons. Brake blocks were applied to every wheel except the engine bogie wheels and the middle pair of the six-wheel coach. The total weight available for stopping the train was therefore 93·2 per cent. Of this fact likewise no hint is given in the report.

Now it is not my purpose to arouse once more the acrimonious discussions that at one time filled our engineering journals as to the relative merits of the rival brakes—by this time the good and bad points of each are well known, and likewise their relative stopping powers—but I have placed the facts in connection with this particular accident in evidence because I think the time has arrived when some steps should be taken to determine exactly how we stand with regard to the action of the present appliances to existing rolling stock. It is many years since any official brake trials have been carried out in Great Britain; the present nature of our rolling stock differs essentially from that in use when the last tests were made. Since then block sections have daily grown closer and shorter, trains are heavier and speeds higher. Of late years several of the great lines have introduced 12-wheel bogie carriages, and the practice appears to be prevalent of omitting to apply brake blocks to the middle pair of wheels. This is, I am convinced, a serious mistake, and the Board of Trade should have power to compel the railways to fit all bogie wheels and likewise the middle wheels of six-wheel stock with brake apparatus. Such tests as we propose would have an important bearing on the position of our signals. In the case of Slough, for instance, if it were proved that at a speed of 68 miles an hour it was impossible to stop a train before reaching the station — supposing brakes to be fully applied on sighting the home signal—then that signal should most certainly be placed further off. Why this important point was not touched upon by the Board of Trade inspector is a question that may well be asked. To me it appears to be an essential element in the safe working of our trains that the actual stopping power of the brakes in use by each line should be known, not by rule of thumb, but definitely and accurately. It should be borne in mind that even those companies which use the same brake do not all use the same type. The Great Western, for instance, use an air-pump and a pressure equal to 25 ins. combined with a steam brake on the engine. The South Eastern use an ejector in place of a pump, and work at a pressure of 20 ins., the vacuum being also used for braking the engine and tender wheels. The Midland use ejectors for the vacuum and have a steam brake for the engine and tender. Even the size of brake cylinders is not the same, and it will therefore be understood that tests carried out by one line could have no relation to any other, and that the results would differ in each case. It cannot be too strongly emphasised that stopping an express train is a matter of seconds and feet, and the sooner we know

exactly how we stand in this respect the better it will be.

The second point to which I wish to direct attention is the rulings of the inspector on the duties of passenger guards. Col. Yorke refers to the subject in the following terms:—

"It is to be remarked that in this case, as in so many others of late years, the guards of the express train were not on the look-out for the signals, and neither of them can give any information as to the position of the signals at the Dolphin and Slough East. I hold that the first duty of a guard is the safety of his train, and the watching for every possible indication as to whether all is right or not. I am supported in my opinion by Rule 170 (General Rule Book), which says: "Guards of passenger trains must *after* the safe working of their train, give their *next* attention to the luggage, parcels and other packages entrusted to them."

Now, whatever may have been the intention of those who framed the above rule, there can be no doubt that as regards its application in the present day—if correctly construed by Col. Yorke—it is a sheer impossibility. The work demanded of the guard of a modern express train puts quite out of the question any but the most cursory attention to signals. Years ago, when signals were fewer, the trains slower, and passenger traffic infinitesimal compared with the volume now dealt with, the thing may have been to a certain extent workable; but anyone who knows the work involved in sorting out a huge 50 ft. eight-wheel van, will at once recognise that the demands of the Board of Trade inspector are quite impracticable. Further, it may be remarked that the side windows provided for the use of guards have been gradually reduced in size until at the present time it is physically impossible to take note of the signals or to keep a proper look-out. If this pronouncement of the Board of Trade is to be taken *au pied de la lettre*, it will be necessary to revert to the old-fashioned roof-seat commanding an uninterrupted view ahead and also to provide an additional guard whose sole duty would be to attend to the signals.

For myself, I consider the remedy worse than the evil, and further, that it would tend to reduce the sense of responsibility, and consequently the attention devoted to signals by the driver and fireman. Apart from this, however, there is no doubt that the size and shape of the windows provided for the use of guards on some lines—notably the Great Western—are most unsuitable, and indeed worse than useless; they should be so constructed that an uninterrupted view ahead

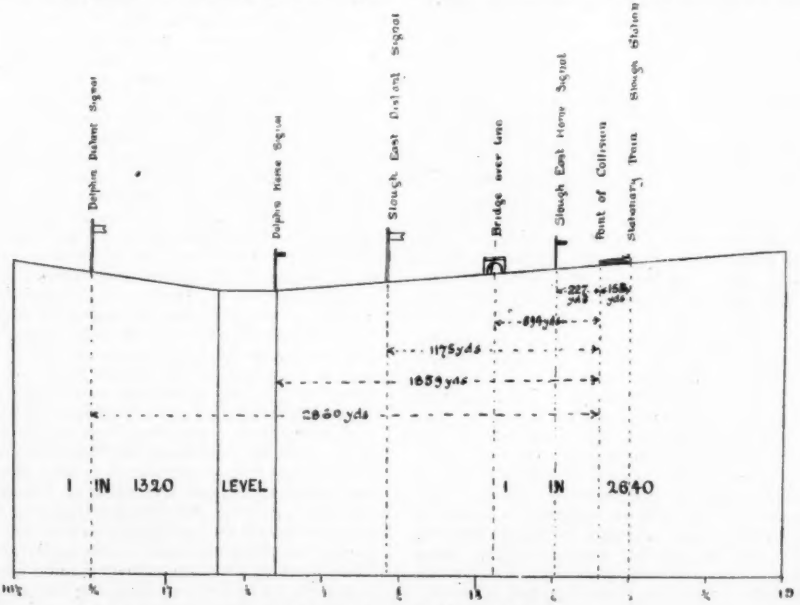


DIAGRAM SHOWING POSITION OF SIGNALS, ETC.

may be easily obtained, and the glass should be kept clean and not in the state of filth which so frequently obtains on some lines.

We now come to a matter which is outside the scope of the Board of Trade report, yet which has in my opinion a considerable bearing upon this particular accident, and also upon the general methods of working our traffic in the present day. It will be remembered that the train which was run into at Slough, being due to leave Paddington at 1.5, did not actually get away until 1.12, or three minutes before the 1.15 was due out. Now the authorities at Paddington must have been aware that in all probability the late departure of the 1.5 would involve blocking the 1.15 at Slough. It would have been a very simple matter for the platform-inspector at Paddington to instruct the driver of the 1.5 that he must do his best to clear the 1.15 by running under his booked time, and making up two or three minutes on the way. Of the possibility and safety of this course there can be no reasonable doubt. The train, exclusive of engine and tender, weighed about 155 tons, it was drawn by one of the recently constructed four-coupled express bogie engines, and was timed to cover the 18½ miles at a booked speed of 46¼ miles an hour. As a matter of fact the driver lost one minute, and we are given no reason for this failure to keep schedule time. It would have been quite possible to run to Slough in 21 or 22 minutes. giving an average speed of 50 or 52 miles an hour, and it is highly probable that the time gained would have enabled the staff at Slough to deal with the tickets and allow the train to get away before the 1.15 became due.

Putting aside, however, the possible prevention of this particular accident, it appears to me that this matter merits very careful consideration by our railway managers. In the present day there would appear to be some unwritten law which demands that under no circumstances whatever shall a responsible railway official give direct orders to a driver that he is to make up time; indeed, it has become a sort of "fetish" which no self-respecting official dare offend, and may only be spoken of by those high in authority with bated breath! Every day the newspapers unfold some fresh tale of unpunctuality and disorganisation, and every day the patience of the travelling public is sorely tried by late arrivals and lost connections, yet little or nothing is done to remedy the evil. Surely it is time we realised our position in this matter! Until some strong-minded man takes the bull by the horns we shall go on from bad to worse, allowing punctuality to become a by-word and demoralisation to become permanent. Let us take this particular instance, and see what it means. The 1.15 *ex* Paddington is not one of the fastest expresses on the line, but is a semi-express, calling at Reading, Swindon, Bath, Bristol, Taunton, Exeter, etc., and making connection at these places with all the important branch lines *en route*. The natural result of delaying this train five minutes at Slough would be a further loss of five minutes at Reading, 10 minutes at Bristol, and so on all down the line, making all the corresponding branch trains late and disorganising the traffic from Paddington to Falmouth, it being a well-known fact that a train which loses time at the start invariably loses further time right through its journey. Now all this might be avoided by the exercise of a little common sense. The line as far as Swindon—or, for the matter of that, to Exeter—is of such a nature that any speed attainable by the locomotive might be run with perfect safety. Yet because of this out-of-date, unprogressive, hypersensitive spirit with which all our traffic managers appear to be indued, we must needs see our railways disorganised, and yearly going from bad to worse, while our reputation promises to fall to its lowest depths.

There are periods during the summer months when it is of vital importance that trains should be run on time. It becomes necessary to duplicate or triplicate, say, the 10 a.m *ex* King's Cross, the first portion leaving at 10, the second at 10.3, and the third at 10.8. If all three are run to the timing of the 10 o'clock then it follows that the two latter portions will be blocked outside Grantham and kept waiting until the first part has got away. Supposing, however, that it were within the power of the inspector at King's Cross to instruct the driver of the first portion to run into Grantham at 11.55 instead of 12 o'clock, it would then be possible to get each portion away without any delay from its predecessor. The result of this method of working would be that instead of all three trains arriving hopelessly late at Edinburgh, they would be enabled to get in within a quarter of an hour of the booked time. As a matter of fact, this particular train is so frequently split up during the summer months that two or three separate timings are shown in the working time book, but the argument is the same and it applies to a very great number of our important expresses. I would suggest that at all the principal stations inspectors should be furnished with a schedule giving the allowable timing of the best trains when running late, the inspector to be compelled to fill in a ticket directing the driver to run to his next stopping place in a certain

number of minutes, allowance of course being made for heavy loads or bad weather. Such a method would, I am convinced, go a very long way towards solving the question of unpunctuality. In France and America, drivers are not only expected to make up lost time but are rigorously dealt with if they fail to do so, and it is only in this country that officials are too timid to take a course which would be thoroughly appreciated by the travelling public.

The following is a brief summary of the points I have dealt with, and which appear to me to merit the consideration of our railway authorities:—

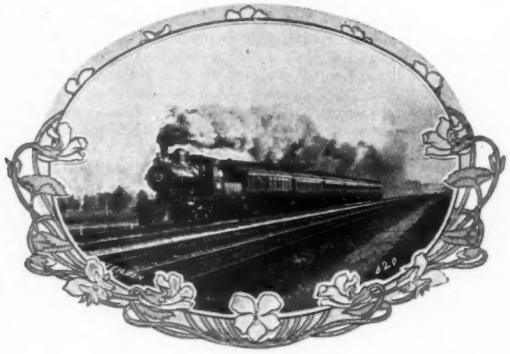
(*a*) Proper brake tests with up-to-date rolling stock should be carried out either by the companies themselves or by the Board of Trade; such tests to embrace all forms of brake apparatus at present in use in Great Britain.

(*b*) All wheels of passenger coaches and locomotives should be braked, and failing the carrying out of same by the railways, power should be granted the Board of Trade to enforce compliance.

(*c*) The look-out windows of guards' vans should be constructed so as to afford an uninterrupted view of the train and signals.

(*d*) Inspectors at all important centres should have power to accelerate the running of passenger trains whenever deemed advisable.

A. G. ROBINS.



WORKSHOP PRACTICE

The purport of this section of FEILDEN'S MAGAZINE is to give the skilled mechanic in our great industrial establishments an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is what we desire to encourage and foster. To this end we invite skilled mechanics, foremen, under-foremen, and heads of departments, to communicate practical suggestions, which, if accepted, will be suitably paid for. Wherever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for publication. Nothing will be too poor for a careful inspection. Questions relating to shop practice are also invited, for which we pay one shilling. Answers to these questions that are printed are also suitably paid for according to merit.

❀ ❀ ❀

A Tool Post Attachment.—The advent of automatic machinery and its universal adoption has opened out a wide area for ideas and suggestions that will improve the different machines. These consist of many inventions and auxiliaries other than those supplied or thought of by the maker. The automatic machine, as used for turning small cones, knurled nuts or washers, from round, square or hexagon stock, is arranged with a series of tools, which come into operation alternately or simultaneously as required. Figs. 1, 2, 3 and 4 show respectively the finished washers at the end of a piece of stock, the side elevation, end elevation and plan of tool post. The parting-off tools *A*, *A'*, *A''* are held firmly in position by the screws (*B*) passing through the clamping plate (*C*). Owing to the pieces sometimes remaining between the tools when parted off, and the occasional jamming of the machine thereby, the following was introduced as a preventive. In this case the parting-off tools were set in advance of one another, so that each piece would be separated in order. Between the tools are sliding pieces provided with a slot, through which the clamping screw (*B*) passes. End pressure on the bars is exerted by the springs (*D*, *D*) fastened on the end of the tool post by the screws (*E*, *E*). As the post travels forwards in the parting-off process the bars are forced back against the springs. On the termination of the cut the recoil of the bar ejects the finished piece from between the cutters, leaving the bar in its normal position, to be again pressed back on the commencement of the cut.

W. HOUGH.

[We think some little difficulty would be experienced in using square stock.—ED.]

A Handy Box Tool.—Below will be found a sketch of a very useful and handy tool that can be used with any lathe. The cut itself is almost self-explanatory, and it is so simple that any mechanic can make one. It is intended to be used either as an attachment to the tail stock by being screwed on to a hollow harbour fitted to the tail stock having the same number of threads and same diameter as the live spindle; or it can be screwed on to the live spindle itself or held in a chuck. Where the tool is screwed on to the tail centre, the stock to be cut is fed through the hollow spindle in the head stock of the lathe, but where the tool is screwed on to the live spindle it of

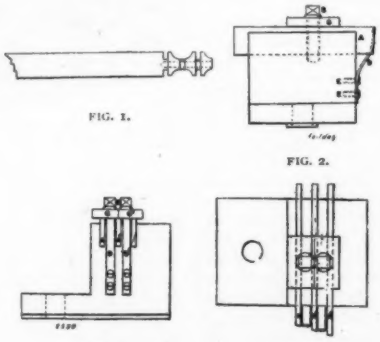


FIG. 1. FIG. 2. FIG. 3. FIG. 4.

A TOOL POST ATTACHMENT.

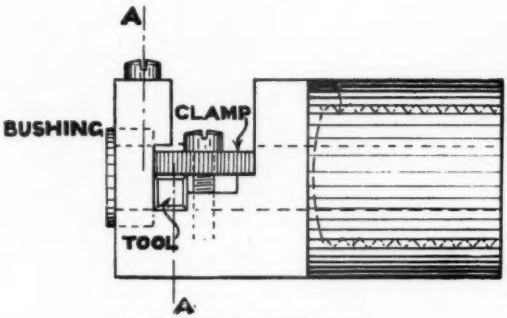


FIG. 1.—SECTION THROUGH BOX TOOL.

course rotates with it, and the work is held stationary. The outer half of the tool is made of a square cross-section, and the other half round. Any size bushing up to the full capacity of the tool may be used, and it will be found very convenient in making screws and other small articles, or for reducing rods to any diameter within the range of the tool.

CHARLES G. TAYLOR, Burlingame, Kansas.

[NOTE.—Sometimes supplied with two cutters, a very useful tool for reducing stock by a single cut to any required diameter.—ED.]

Flanging Light Pipes.—A cheap, simple, and effective way of attaching flanges to light pipes is as follows:—Boiler tubes of 4½ ins. and 6 ins. diameter were required to be flanged for a special job, the thickness, 9 and 10 B.W.G., not allowing for thread in the usual way. Mild steel flanges ⅝ in. thick were bored a $\frac{1}{64}$ in. larger than the external diameter of the tube, and shallow V-grooves, about ⅛ in. apart, were cut within the bore of the flange. With the aid of an expander the periphery of the tube was forced into the groove, making an excellent job. The ends of the tubes were left projecting a little beyond the flange faces, to be afterwards dressed off level.

J. LESLEY.

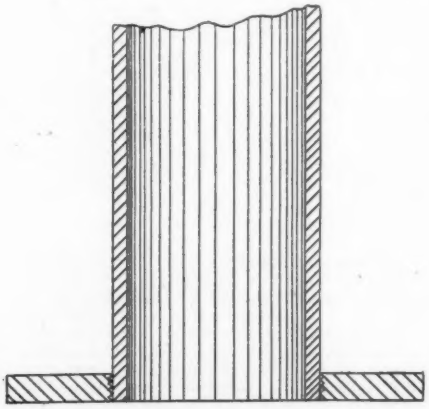


FIG. 1.—METHOD OF FLANGING LIGHT PIPES.

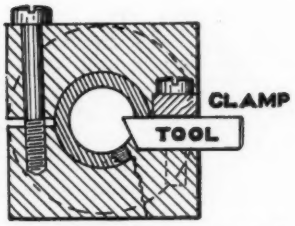


FIG. 2.—SECTIONAL VIEW ON LINE A—A OF FIG. 1.

Topping Cylinder Flanges.—In many designs of horizontal and other engines, it is the custom to form up the flanges almost flush with the ends of the cylinder, thereby extending the base of the same, so as to give stability by spreading the base on the foundation, and also to allow of the valve chests of Corliss engines to be placed as near to the ends of the cylinder as possible. When thus formed, the full diameter of the cylinder flange extends only half or two-thirds round its circumference, and then falls away into the body of the cylinder casting. When boring and facing such cylinders it is a common practice to strike a circle with the tool in the facing rest, the full diameter of the cylinder cover, and then chip and file the flange to the level of the covers. In very large cylinders the above process involves a serious item of cost, and a special tool or machine to perform the work would in its turn be very costly, especially if designed to have a range sufficient to deal with cylinders say from 12 in. to 60 in. diameter. In order to reduce the time in topping such flanges, the following simple method will be found to effect a saving in both time and labour, and give greater accuracy to the work,

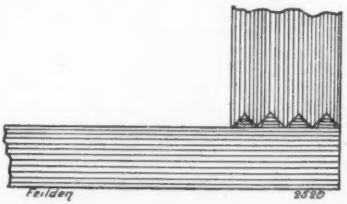
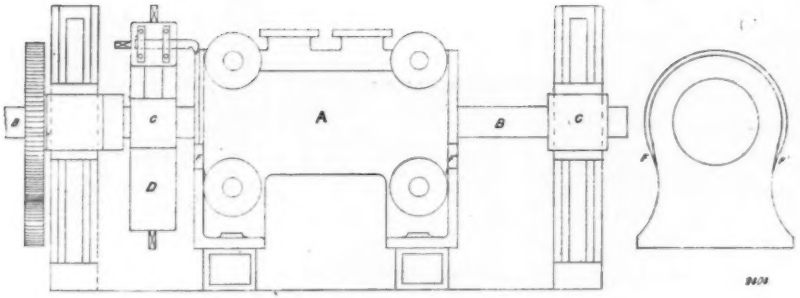


FIG. 2.—ENLARGED SECTION OF EXPANDED TUBE AND FLANGE.



CHEAP METHOD OF TOPPING CYLINDER FLANGES.

there being no ragged edges left when completed. The sketch shows a Corliss cylinder *A*, with flush end flanges fixed on boring bed; *B* is the boring bar inserted in the cylinder, and carried in two standards *C C*. *D* is the facing rest bolted securely on the boring bar, and having a slide working at right angles to the bar for facing, on which is carried a slide or tool-holder *E* to feed forward and backward, parallel to the bar and over the top of the cylinder flange. The sketch shows the usual arrangement for cylinder boring, and the operation of topping may be described as follows:—Assuming that the cylinder has been bored and faced, and also that the diameter of cover has been struck on the face, we proceed to chip a clearance of two or three inches down to the line at the points *F F*^{1}, Fig. 2, for the convenience of starting and finishing; then by alternately inserting and withdrawing the tool at these points, the edges of the flanges may be formed to any required section or diameter. If the rest be a strong one, a cylinder flange may be reduced three-quarters of an inch in diameter with one roughing and one finishing cut. By this method very satisfactory results have been obtained, and a great saving of labour effected.

"STRAND."

Junction of Mouldings.—Cases frequently occur in connection with fitments where it is necessary to cut a cornice moulding to butt *square* against a corresponding moulding, and much time is wasted in measuring, scribing, and cutting to fit by trial, unless the correct and simple way is known. All that is necessary is to cut the piece being fitted (*A*) to a mitre (45 degs.) and then with saw, gouge, and chisel *remove all the part in section* when the two surfaces will exactly fit against each other (Fig. 1). Should the angle be other than 90 degs. the same principle applies, the moulding being sawn at half the angle made, and the necessary slope being observed in removing the waste material *B* (Fig. 2). In Fig. 2 the lines parallel with the grain indicate the portion removed in mitring, the parts afterwards cut away being represented by dotted lines *in the direction of the cut*.

H. A. MILES.

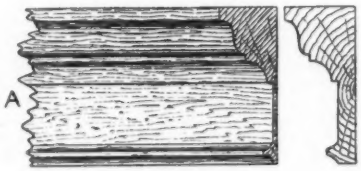


FIG. 1.

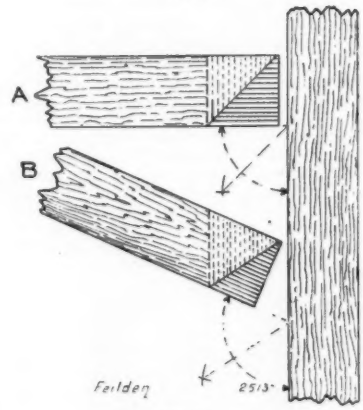
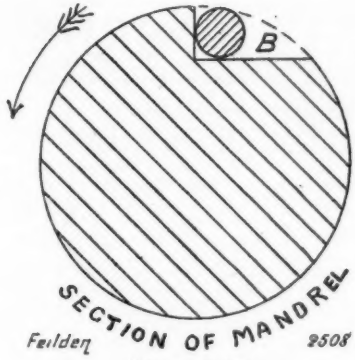


FIG. 2.

METHOD OF JOINTING FOR MOULDINGS.

An Improved Mandrel.—An improved mandrel for lathe work can be so arranged as to prevent the spreading of the ends and the destruction of the centres by making an ordinary solid mandrel a sliding instead of a driving fit. This is accomplished by milling away a portion *B* for the entire length. This section must be cut to a depth that will coincide with some convenient diameter of steel rod, say about $\frac{1}{4}$ in., making the periphery of one exactly meet that of the other. When working, the mandrel is revolved in the direction



AN IMPROVED MANDREL.

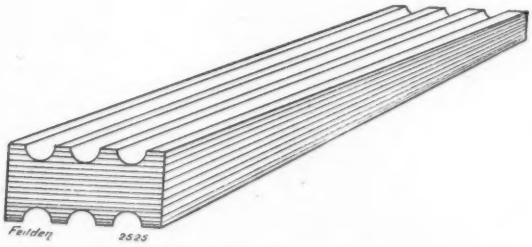
of the arrow, and a good depth of cut may be taken without slipping. A slight tap in the opposite direction enables the work to be slipped off easily. W. HOUGH.

[Very useful for repetition work, when taking a peripheral cut *only*, but not enough resistance for side cutting.—ED.]

cramping or binding in some direction. Grooving the surface of a wedge is something of an innovation, and though the principle of relieved surfaces is often met with in the fitting and turning shops, it is seldom thought of in the foundry. The illustration shows a new style of wedge, with longitudinal grooves, and made in malleable iron —a very considerable saving over forging. The faces give a better grip than the ordinary flat wedge, and with less tendency to rebound.

"BRASSEY."

A Stay Bolt.—A convenient bolt for staying purposes may be made from materials to be found in any engineering shop, and the device is one that will accommodate itself to a variety of jobs, thus dispensing with an accumulation of stock round the machines in the shape of an interminable number of bolts. A piece of 1-in. gas tubing, about 2ft. long is screwed on the outside with a fine thread at one end, and fitted with a hexagon nut 2-in long. The tube is then drilled on one side with ⅜-in. holes, 1-in. pitch as shown. A sliding collar on the tube carries a set-screw which is tightened up on a bolt of the internal diameter of the pipe, up which it may be moved to the required distance, the other end of the bolt terminates in an ordinary hexagon or square head. Any sizes may be made in a similar manner, the

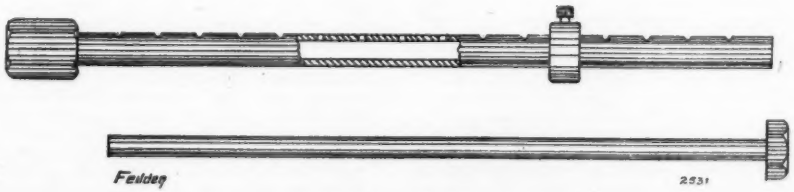


GROOVED WEDGE FOR FOUNDRY USE.

A Grooved Wedge.—The wedge is perhaps one of the most useful accessories of the moulding shop, as nearly all kinds of foundry work require

long nut on the end giving any intermediate adjustment between the holes.

SETH FORTUNE.



CONVENIENT FORM OF STAY BOLT.

INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION

FROM ALL SOURCES.

MECHANICAL ENGINEERING.

A Revived Motor System.—A car in which superheated water is used as a source of power has been recently tested on the New York Central Railroad; and, from the description, it appears that the method employed for working it is a revival of Lamm's system. The car has a length of about 35 ft., and is fitted with special motor trucks and storing tanks for the hot water, suspended under its body. These tanks are three in number, each about 24 ins. in diameter and 12 ft. long, and are charged with hot water at about 500 degs. Fahr. at a central station. In operation this water is drawn from the tanks in small quantities at a time, and allowed to partly expand into steam at a pressure of 100 lbs. per sq. in. This action takes place in a chamber adjacent to the engine cylinder in which the steam is used. The car on the trial trip was provided with a duplicate engine on each truck, but only one set of engines was used. Motion is transmitted from the crank shaft of the engine to the car axle by spur gears.

Turbo-Motors.—The Hon. C. A. Parsons, during the discussion on his paper on the steam turbine and its application to fast merchant vessels, read before the Institution of Shipbuilders and Engineers in Scotland, made the statement that in four years his "Turbinia" had run 34,000 miles and there are no signs as yet of any deterioration. One of a number of turbines built by him in Newcastle in 1887 was taken to pieces last year and a careful microscopical investigation failed to reveal any signs of usage. With clean steam no noticeable wear seems to take place. A $\frac{3}{8}$-in. nut having got "chewed up" recently, it was assumed that some damage had been done to the engine, but the turbine had not been hurt in the least. These facts plainly show that with ordinary care turbines seem to be much less liable to derangement than ordinary engines, especially with superheated steam, which certainly adds considerably to the value of the new type of steam motor and should go far in securing its more general adoption.

An Improved Expanding Mandrel.—In a recent issue of the *American Machinist* an expanding chuck or mandrel for the rapid and easy execution of small articles, difficult to hold in any other way, and suitable for the turning of collars, for instance, is described, and the patentees, Messrs. J. & W. R. Thomas of Pennsylvania, may truly be said to have met what all iron-turners will agree to have been a long-felt want. With this useful tool a collar may be turned on the outside, and faced on both edges at one setting, and the design of the chuck is as follows. Its body consists of two parts, the first, or back piece, of which may be screwed on to the front of the lathe spindle, or otherwise securely mounted. The second piece is bolted to the first with a round chamber between them in which a large nut is fitted to turn freely. The periphery of the nut has several holes in which a pin may be inserted for turning it, and the body of the mandrel is cut out at the side to allow a sufficient movement of the pin. A threaded stem passes through this nut, the front end of it attaching to or forming a part of a cylindrical block fitting in a cylindrical chamber considerably longer than itself to allow it the required longitudinal movement. This block has three inclined grooves, and against the bottoms of these grooves bear the ends of three chuck-jaws. The outer ends of these hold the work by being forced out against the interior of it. As the cylindrical block is moved forward the jaws are forced outward, and *per contra*.

Strengthening Cast-Iron Pipes.—In the year 1898 an experiment of reinforcing cast-iron pipes was tried at Lyons, and the result has been so successful that not a single pipe then laid down has given way. The method by which the pipes were strengthened was invented by Mr. X. Roge, the managing director of the Société Anonyme de Fonderies de Pont-à-Moussen, and received a prize at the Paris Exhibition last year. The pipes are cast vertically of ordinary iron with external transverse ribs, and the strengthening consists in shrinking on them steel hoops. Numerous trials have shown that cast-iron pipes of normal thickness thus treated can stand violent shock and great internal pressure far better than an ordinary pipe. An ordinary pipe to show the same strength would have so much increased in thickness that its cost would be far greater than these pipes strengthened with steel hoops. Another advantage in the use of the latter consists in the fact that, while an ordinary pipe that bursts generally opens over its whole length, or nearly so, allowing a large volume of water to escape, such opening is, in the strengthened pipe, limited by

the hoops, so that the volume of water escaping is far slighter.

Mining Machinery.—From reliable information it appears that the present moment offers an excellent and unrivalled opportunity for the manufacturers of mining machinery to gain a good footing for a profitable export trade in Chili. To support this view it may be mentioned that during the year 1899 the imports of mining machinery amounted to £14,600 as against £7,400 in 1898, and according to a careful inquiry made in the various mining centres of the Republic the business done last year shows an even greater increase in the figures referring to imported machinery. In 1899 Great Britain was slightly in the lead, her imports of mining machinery amounting to £7,350, while Germany followed with £7,000, the imports from United States amounting only to £250. There seems to be no good reason why our lead should not be continued, for British manufactures in this line are second to none, both as regards durability and finish, and when once known have nothing to fear from foreign competition, provided that our makers pay careful attention to the rapid progress in modern mining methods. The favourable condition for exporters, seen from the figures above given, is apparently not of an ephemeral character, but still continues, as only quite recently a number of new mining companies have been formed in Chili, while several of the old plants have been overhauled with the object of providing an entirely new equipment for which large sums are to be expended in consequence of the profits obtained within the last three years from similar investments.

CIVIL ENGINEERING.

The Cost of Steel and Wood Combination Bridges.—In view of the generally acknowledged skill and ingenuity of American engineers in the designing and construction of bridges, our readers will be interested, no doubt, in the following data regarding a typical American type of bridge, representing a combined steel and wood structure, which has met with considerable success in the United States owing to its economy as compared with the cost of all-steel bridges. The bridge which forms the basis of comparison was built by Messrs. L. Schreiber & Sons of Cincinnati, Ohio, and had the following dimensions:—Span, 190 ft.; road, 27 ft., two walks, each 6 ft. wide; total width, 41 ft.; depth of truss, 27 ft. to 38 ft. The uniform live load on the floor was calculated as representing 100 lbs. per square foot; the floor was covered by 4-in. wood block paving on a 3-in. plank. The contracted live load on floor was to be equal to a 15-ton roller, or two electric cars on each track, which represented a live load of 3,300 lbs. and a dead load of 2,345 lbs. per foot of bridge. The trusses were pin-connected. For the combination design hard pine was used for the top chords, web posts, portals, lateral struts, floor beams and joists, while the remaining parts were of steel. The estimated quantities of materials, given in weight, were as follows:—Eye bars, 42,180 lbs.; cast-iron joint blocks, 19,720lbs.; lateral rods, 5,810lbs.; machine work, 5,940lbs.; shoe plates, 5,200lbs.; loops, 3,160lbs.; mangers, 1,240 lbs; giving a total of 83,250 lbs. at an aggregate cost of 3,130 dols. To this have to be added: hard pine chords and posts, 17·50 mm.; hard pine lateral struts 3·80 mm.; floor planks, 1,974 mm.; floor joists 22·24 mm.; floor beams 14·80 mm., representing a total of 77·36 mm., at an aggregate cost of 2,400 dols. Besides this there were 504 sq. yds. of paving at 750 dols.; 400 ft. of fencing at 200 dols, and the cost of erection, *i.e.* 1,200 dols., which brings up the total cost for one combination span to 7,600 dols., a sum equal to one dol. per sq. foot of the total floor. If the same bridge had been an all-steel structure, the quantities required and the cost incurred per span would have been:—steel, 180,000 lbs. costing 7,360 dols.; floor planking 19·74 mm. and wood joist 22·24 mm., costing together 1,435 dols.; fencing 400 ft. at 200 dols. and paving 504 sq. yds. 750 dols., cost of erection, 1,200 dols.; giving an expenditure of 10,945 dols. for one steel span, which is equal to 1·43 dol. per square foot of total floor. The above comparison applies to the whole superstructures complete. If the cost of substituted parts only is taken into consideration we obtain the following results. In the combination design, the top chords, web posts, portals, lateral struts and floor beams contain 35·3 mm. of hard pine at 35 dols. per mm., *i.e.* 1,220 dols.; 19,700 lbs. of cast-iron joint blocks at 3 cents. per lb., *i.e.* 591 dols., giving a total of 1,811 dols. For the all-steel design the same parts contain 118,200 lbs. of steel at 4 cents. per lb., *i.e.* 4,728 dols. On comparing the above data we see that, roughly, the combination type costs one-third less than the all-steel type, and the same proportion results from comparing the cost of wood, including the necessary cast blocks, with that of steel for top chords, web posts, portals, lateral struts and floor beams; which is a saving well worth taking into consideration.

MARINE ENGINEERING.

Direct Ocean Traffic to Chicago.—The remarkable progress in engineering methods due to the great discoveries in science made during recent years, and to their practical application, has rendered possible many changes in the conditions of countries and places, the mere suggestion of which would have formerly been laughed at. The building of railways and telegraph lines through deserts, the tunnelling of gigantic mountains, the cutting of canals through necks of land that for thousands of years have defied the inroad of mighty oceans, are all problems solved already, and to be solved again whenever occasion arises. And a problem similar to these in so far as not so very long ago it would have been decried as absurd, but at present is recognised as quite feasible, is the transformation of some important inland town

hundreds of miles from the ocean shore into a commercial port accessible to the great vessels crossing the Atlantic or Pacific. For some years schemes for bringing such ships to Berlin have been under serious consideration and will sooner or later be put into execution; and quite recently the first step has been taken to secure for Chicago the privileges of an ocean port. While to do this for most of the inland towns suitable for the purpose would require the enlarging of some river beds, the rectification in some places of their banks, the construction of a few canals and the building of a fleet of sea-going vessels, the latter alone practically suffices for making Chicago a seaport, since there is a waterway quite ready for such a fleet, which would merely have to pass through the Welland Canal to reach the St. Lawrence and the ocean. True, the Welland Canal permits only the passage of vessels of not more than 14 ft. draught, which will make it necessary to take a considerable portion of the load off vessels that when fully loaded have deeper draught, and carry it on lighters to the St. Lawrence or to Montreal, to be later re-transferred to them; but even so the change will be of far-reaching importance for Chicago, where, as probably will be found in the near future, vessels can be built cheaper, owing to favourable proximity of the town to the sources of the raw material, than in the Atlantic coast towns. The beginning for the transformation has been made—*i.e.* an ocean freight-carrying vessel has been launched at the yards of the Chicago Shipbuilding Company, and three similar ones are in course of construction. This little fleet will cost, it is said, the moderate sum of one million dollars. Larger vessels have been built in Chicago before this, but they were intended for lake steamers. The one recently launched is to run directly between the Western Metropolis of the United States and European ports; and in this lies the significance of the fact, which is fully realised in the United States.

RAILROADS.

Bogie Steel Wagons.—Experiments are being made by the Furness Railway Company bogie steel wagons for the conveyance of iron ore. These wagons are designed to carry 40 tons of ore with a tare of only 12 tons 7 cwt., and one of these wagons will actually do the work of four ordinary wagons. For the time being the new steel wagons are running only between the Barrow docks and the Barrow Steel Company's works, but their complete success has been demonstrated, and the directors have announced that they intend to ask other ironmasters in the district to make certain alterations in their works so as to be able to supply them with more wagons of the same type which they intend to order from them, since they will use these steel cars henceforth generally on their line.

Steel-Tyred *versus* Cast-Iron Wheels.—The use of steel-tyred wheels on railways is of comparatively recent origin, for it was inaugurated in Great Britain during the early sixties and adopted in the United States a few years later. In the latter country, nevertheless, steel tyres were employed for a considerable period of time on a few lines only, and the use of cast-iron wheels with chilled tyres was almost universal. In recent years, however, the transformation has been very rapid, and cast-iron wheels have practically disappeared. In a recent issue of *Locomotive Engineering* a writer, who has for many years been engaged in the manufacture of the more expensive, but also more durable, steel tyres, publishes a very instructive comparison between the two types, of which the following is a summary. According to him the life of a cast-iron truck wheel, as it is technically called, is conceded to be 50,000 miles' run. On trunk lines they are now used only on freight cars. The steel-tyred truck wheel has a record of over 600,000 miles' run before it is unfit for service. It will thus be seen that there is a very marked difference in the "life," and there are some kinds of steel-tyred wheels that can be replaced with new tyres almost indefinitely, so that their "life" may be almost called endless. The steel-tyred truck wheel is now used exclusively on passenger trains on all trunk railroads in New England. When first used in America there were some misgivings that, owing to climatic conditions, when subjected to the strains of railroad work, they would break. This fear has been dispelled by the production of better qualities of steel. The resistance due to curves on the track is a great factor in the wear of a wheel, causing its removal sooner than the actual wear on the tread demands. On a curve the flange of a rigid tyre acts as a shearing machine; it cuts the rails and is cut by the rail. Many devices have been tried to avoid this, but the old system of two wheels fixed to the same axle remains. "Coning" the tread is of some aid, but only for a few thousand miles. On six-wheel trucks, owing to increased wheel-base, this friction is increased, and on those trucks cut flanges are more frequent. Sliding the wheels is another factor in their wear, and adds considerably to the time required to turn them.

Railroad Construction in Italy.—British locomotive builders will be interested to learn that the Mediterranean Railway Company, of Milan, Italy, will purchase part of its new rolling stock in foreign countries. The company is to spend for this purpose about 3,400,000 dols. The Tramway Company, of Messina, Italy, is to convert its steam line into an electric road. Giovanni Stuchy, of Giudecca Mills, Italy, has presented to the Mayor of Venice three projects intended to join the Isle of Giudecca and Venice; two of the projects have been conceived by Frote & Westerman, civil engineers, of Zürich, Switzerland, and would cost 50,000 dols. and 130,000 dols. respectively; the third project, which was planned by Mr. Krukenker, of Hanover, would cost 150,000 dols. La Societa Veneta has applied to the Italian Government for a concession for a railway from Portomaggiore to Migliavindo.

METALLURGY.

A New Metallurgical Process.—Among the patents granted to the late Dr. Carl Hoepfner, not long before his decease, in conjunction with Mr. John Offegor, was that for a method of recovering zinc from argentiferous blends in which the percentage of iron is too large to permit the ordinary distillation method being used. This method, it appears, is being successfully employed at present on a commercial scale and consists of the following operations. The ores are at first roasted with common salt, resulting, according to the description, in the production of zinc chloride and sodium sulphate. These two soluble salts are then leached out, and the latter separated from the former by crystallisation in the cold. The zinc chloride is then treated electrolytically, using carbon anodes and for cathodes a revolving plate of zinc. The chlorine as it escapes is absorbed by lime, making a marketable product. The process is said to be in operation on a considerable scale at Farfurth. The precious metals, of course, remain in the leached residues in the tanks. If rich enough these could be sold direct to the smelter. If not, they would require concentration.

Variation in Foundry Iron.—The varying character of pig-iron is, as we all know, a source of constant annoyance to the iron master; and for this reason the paper recently read before the American Foundrymen's Association, by Captain Hemming of the Imperial German Artillery, which contains many useful hints regarding the causes of failure in castings, deserves the attention of all who are interested in iron-working. Chemical analysis is frequently mentioned as of the greatest importance to the founder, but from Captain Hemming's paper it appears that chemical knowledge will be of even greater use if it is used to guide the work at the blast furnace. Chemical inquiry into the character of the iron used in foundries does not suffice to establish the suitability of foundry iron, and the latter appears to depend even more upon the physical properties of the iron; since specimens of iron absolutely identical in composition often give totally differing results in the foundry, while equal results are often obtained with specimens differing considerably in constitution. These facts, as the author of the paper points out, make it highly important to ascertain the true cause of the different behaviour of iron when used in foundry work, and it is a great mistake to blame the founder for the failure of obtaining equal results from iron which analysis shows to be of equal composition. Poor moulding, cold iron, unequal cooling, abrupt change of section, trouble in the place from which the test pieces were cut, or difficulties in making a separate set of test bars, are considered as the primary causes of failure to see predictions carried out. It is also known that the cupola itself has a great influence on results, for, with the same mode of operations and material, one day's run may be quite different from the other. The author's experience in one foundry has shown that different shipments of one brand of iron, in spite of a practically identical composition, may produce quite different results, and that the foundry will not be to blame therefor. This particular foundry was accustomed to work with such painful exactness that the conclusion was forced upon all of those interested that the root of the evil was to be looked for in the blast furnace. It is a well-understood fact that even with the most uniform burden a blast furnace cannot make absolutely uniform pigs, so far as their composition is concerned, yet the end product will be comparatively more homogeneous than a cupola process could make it, for the quantities are much larger, and the process is a continuous one. If, now, the greatest care is taken in running the cupola and handling the molten metal, the unavoidable differences in composition in the castings made will be found to be quite unimportant if only the same care is taken with the burden in the blast furnace. There are pig irons sold, as among the best, which still contain 4·9 per cent. total carbon, silicon 2 to 2½ per cent., manganese 0·6 to 0·7 per cent., phosphorus 0·94 to 1·20 per cent., and sulphur 0·10 to 0·14 per cent., and it is not to be wondered at that the results are poor. Where the percentage of iron is dropped down to 80·65 per cent., instead of being 92 per cent., castings must be failures. The tendency of German practice is to burden the furnace to produce a maximum amount of silicon. The result is a maximum of other things not so desirable, and the complaints heard so often about bad iron are fully justified.

MISCELLANEOUS.

Aluminium.—Though but a few years ago aluminium was one of the rare metals, since the advent of electro-metallurgy on a commercial scale it has been transformed into one of the cheapest and, in some lines, one of the most extensively used products. The figures showing the rapid increase in the output will be startling to many of our readers. In 1889 the total aluminium production of the world was estimated at 71 tons, of which the United States contributed 21·6 tons. In 1890 the total amounted to 165 tons; the production of the United States to 28 tons. By 1891 the total had risen to 233 tons, the American share only to 68 tons. Two years later the two figures were 716 and 154 tons. Then the United States began to push the production at a more rapid rate. In 1896 the comparative figures were 1,660 and 591 tons; in 1897, 3,394 and 2,814 tons; in 1898, 4,500 and 2,360; in 1899, 6,000 and 2,950; and in 1900, so far as estimates allow to state, 7,500 and 4,000 tons. The United States would thus supply more than half of this metal, which, it must be acknowledged, has found the widest application in that country.

The Metallurgy of Aluminium.—With the remarkable increase in the aluminium production of the world, our knowledge of treating this interesting metal also is growing. The problem of soldering aluminium, for some time defying all

efforts of the most distinguished chemists and metallurgists, has quite recently been solved in a very satisfactory manner by utilising its peculiar property of becoming plastic long before its melting point is reached and by kneading the ends of wire, or the edges of pieces to be joined. The latest addition to our knowledge of treating this metal is due to the publication, by Mr. Sichelstiel, of the *modus operandi* for welding sheets of aluminium upon other metals, invented three years ago by Mr. Wackwitz, of Nürnberg, but kept secret hitherto. It is well-known that it is not possible, in the ordinary way, to unite a plate of aluminium and copper by heating, for at the temperature at which the former metal melts, *i.e.* at 700 degs. C., copper shows distinct signs of oxidising, the result being that an alloy formed at this degree of heat is brittle and unsuitable as a cement to which another sheet of aluminium might be fastened. Mr. Sichelstiel, however, demonstrated that when a very thin foil of aluminium is pressed on copper, oxidation of the copper does not take place, and, on heating, an alloy is formed in which copper predominates. If now a thicker foil of aluminium is placed upon the thin aluminium coating of the copper and the whole is passed through a system of rollers, the thicker layer of the aluminium will adhere. The same process may be applied to other metals, however widely they may differ in melting-point. In this way iron, steel and zinc can be plated with aluminium, and upon the latter metal again a layer of copper can be placed. Among the various combinations that can thus be formed Mr. Sichelstiel showed to his audience a sheet of iron plated on both sides with aluminium. There is no doubt that this process will be utilised in many ways, though for the moment it is of merely experimental interest.

New Works.—Messrs. Browett, Lindley & Co., Ltd., of Patricroft, near Manchester, report that they have now got their new extensions in complete working order. The new machinery for which the orders were placed when the Company extended its capital having been delivered and put to work, the new extensions are now quite completed. It is interesting to note that originally the London works consisted of two main bays 176 ft. long by 88 ft. wide. One of these was used as an erecting shop, and was served by one 10-ton overhead travelling crane; the other portion being the machinery department. In the years 1895 and 1896 these shops were extended in length by 120 ft., and another 10-ton crane was provided. During last year a new main erecting bay, 384 ft. long by 48 ft. wide, with a head room of 26 ft. under the cranes, was completed. This erecting bay is served by two 20-ton overhead electrical travelling cranes, and at the end of this shop a complete testing department has been installed complete with all electrical resistances, instruments, etc.; and steam is supplied by two Climax water-tube boilers having a total capacity up to 1500 h.p. A large lodge has been erected to supply the water for the surface condenser used for taking steam consumption tests. Although this Company are so extremely busy, we may mention that, as they work continuously night and day, the output has been very greatly increased, and they are thus enabled to give quick delivery of standard sizes.

Artificial Fuel.—Through the aid of science the immense tracts of peat found in Eastern Prussia will, in the near future, become valuable property; for, according to the *Königsberger Allgemeine Zeitung*, after numerous failures, a process has been invented for transforming peat into a fuel of a heating power greater than that of good English coal and almost equal to that of anthracite. This process requires no elaborate machinery, it appears, and when worked on a large scale will enable the patentees to produce the material at the low price of m. 5 per ton.

The Depressions in the German Iron Trade.—There can be no doubt that the makers of manufactured iron in Germany continue to suffer from the anomalous condition caused by the high prices of pig-iron which mine-owners are maintaining regardless of the changed conditions. According to *Glückauf*, a well-informed trade paper, the situation is as follows: Makers of finished iron have been obliged to make concessions, while producers of raw stuffs stick tenaciously to previous quotations and contracts. The result has been the throwing of goods on the market without profit, and in many cases the stopping of work. Until more uniformity in prices is attained there will be little confidence, and orders will be held back, causing losses to makers. Owners of blast furnaces experience slow sales, and are obliged to accumulate stocks. The Ironmasters' Union will not reduce the old prices, and the immediate result has been the consumption of English pig-iron in places.

Canada and the Great Steel Trust.—It is satisfactory to learn that Canadian manufacturers appear to look with great equanimity upon the proceedings of the managers of the great steel trust in the United States. Mr. A. J. Moxham, general manager of the Dominion Iron and Steel Company, is evidently not in the least discouraged by the alleged danger, but, on the contrary, believes that Canada will succeed in ousting the steel makers in the United States from their dominant position. In support of this opinion he states that the new Canadian works at Sydney, Nova Scotia, have an advantage of fully 25*s.* per ton over Pittsburg. The ore used in these works comes from Belle Isle, Newfoundland, and is shipped a distance of 402 miles, the cost of transport being 1*s.* 8*d.* per ton. This ore contains 52 per cent. of iron. The lime for flux, of an extremely pure quality, is delivered at Sydney at a cost of 7½*d.* per ton for freight, while suitable coal is obtainable in abundance close to the works. This makes it possible to collect all the materials required at a price amounting to 3*s.* 3¾*d.* for the production of one ton of pig-iron, while at Pittsburg, notwithstanding the enormous amount of capital expended in

facilitating transportation, the price is said to be not less than 10*s.* 2½*d.* per ton. To this must be added the fact that Sydney is on the seaboard and therefore has far greater facilities for shipment to all over-sea places than the Pennsylvanian town.

Canadian Government Aid to Science.—Among the most welcome news that has reached us recently from the other side of the Atlantic is he information that the Government of Ontario has decided to aid in a liberal manner Toronto University, and thus to put an end to a condition of affairs that must have been painful to all who know the excellent work done in that seat of learning, which used to be considered, and justly so, one of the leading educational institutions in North America. The rapidly increasing demand for scientific training, caused by the recognition of the fact that such training nowadays is indispensable, not, as formerly imagined, for those only who wish to enter the learned professions, but equally so for those who desire to obtain success in industry and commerce, required an extension in equipment and teaching staff for which the endowments of the institution have long since ceased to be adequate, and the natural result has been that young Canadians have been obliged of recent years to pursue their studies in the sumptuously equipped colleges of the United States or in Europe. At last, however, the authorities seem to have recognised the fact that, in view of the enormous resources of the Dominion which are just beginning to be utilised, and the circumstance that the Province of Ontario itself is developing into one of the most important industrial areas in the world, no money can be better invested than that which is utilised for making Toronto University the best educational institution on the continent. A measure has been introduced in the Legislature, and become law, by which the Government is to undertake henceforth the entire expense of maintaining the departments of chemistry, physiology, geology, and mineralogy. The amount to be devoted to this purpose will, in the beginning, it appears, be about 25,000 dols. a year; but will be increased from time to time, so as to keep step with the increasing requirements. Besides this, the Government of Ontario have decided to build and equip an up-to-date technical institution, to be known as the School of Practical Science, at a cost of at least 200,000 dols. For this praiseworthy change in the state of affairs the country is said to be mainly indebted to its Premier, the Hon. G. W. Ross, who, in that case, will certainly have secured for his name an honourable place in the annals of the Dominion.

German Commerce with Russia.—However much the attitude of the German Government toward Great Britain may have changed, it is not likely that Germany will ever permit her relations with other countries to interfere with her friendly attitude towards Russia. Not only is this powerful neighbour, especially when in alliance with France, too dangerous to her as an enemy, but also her commercial interests demand that she should keep open for her industries a market second to none in importance for her among the markets of the world. Far from relaxing her friendly attitude towards the country of the Czar, Germany is constantly increasing the ties that promote the intercourse between her people and her Russian neighbours. According to the Deputy Consul of the United States in Frankfort-on-Maine the German-Russian Association of Commerce and Commercial Firms in Germany, an organisation called into life some time ago with the object of stimulating commercial intercourse between the two countries, has just presented a memorandum to the Chancellor of the German Empire, in which he is urged to introduce measures into the German Reichstag discriminating in favour of Russian grain in case there should be adopted an increased import duty on imported food-stuffs. Of course, this step has been taken in the hope that Russia will reciprocate and make tariff concessions in favour of German manufactures. The desire to remove all obstacles in the way of Germany's commerce with Russia is natural enough, since, as the memorandum points out, German exports to Russia have increased within the last ten years from m. 183,000,000 (£9,150,000) to m. 366,000,000 (£18,000,000) and unless the existing relations are disturbed, there is no reason why this increase should not continue. On the other hand, should Russia be treated in an unfriendly manner and provoked to retaliate, German industries might receive a serious blow; for manufacturers in the United States are making strenuous efforts to capture whatever can be obtained of the Russian area at present held by Germany.

Another Canadian Paper Mill.—It is stated that the Keewatier Power Company is about to construct and operate pulp and paper mills on Funnel Island, and has constructed water-power on the west branch of the Winnipeg river at a cost of 500,000 dols. The company desires to obtain from the Government the right to cut on Crown lands pulp and other woods for the manufacture of pulp and paper. The agreement provides that the company shall erect a pulp and paper mill in connection with the water-power, and thoroughly equip the same. The expenditure of these works is to amount to at least 1,500,000 dols. The output of pulp and paper is to be at least 40,000 tons annually, giving continuous employment to an average of 500 hands. Of the sum mentioned 500,000 dols. is to be spent within one year of the ratifying of the agreement, 500,000 dols. within two years, and the balance within three years. The erection of the mills and the establishment of the industry will form part of the consideration of the agreement for the price of the pulp-wood. The Government grants to the company the right for 21 years to cut and remove spruce, poplar, whitewood, and banksian or jackpine from Crown lands on which these woods are found, and which may be unlocated and unsold, along the rivers and streams tributary to the Lake of the Woods. In no case, however, will this right extend beyond a distance of five miles back from the shores of the rivers and streams indicated.

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In this section is presented every month a concise précis of the contents of the leading organs of the technical press and of the proceedings of the learned societies throughout Great Britain, the Continent, and America, and also, in a summarised form, the subject matter of the more important articles appearing therein.

This systematic record should prove of the greatest value to those of our readers interested in one or more specific sections of technology, trade or economics, or to those who have insufficient leisure to peruse the large number of publications now appearing.

In most cases where publications are not readily procurable, with the exception of Transactions of the Learned Societies, copies of the articles can be supplied on application by remitting 7d. Should any of our readers desire further information we shall be happy to supply it.

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ARCHITECTURE AND BUILDING.

1. Construction and Design.

Ball Bearings.—*Steel Ball Bearings.* Description of a number of important experiments conducted by Prof. Stribeck, at the Centralstelle für Wissenschaftlich-Technische Untersuchungen, at Neubabelsberg, Berlin, on behalf of the German Arms and Ammunition Works of Berlin, in order to determine the elastic forces of steel spheres, plates, and ball bearings under heavy loads. The description is based on Prof. Stribeck's own account of the experiments published in the "Mittheilungen" of the institution, and deserves attention, as the results of the tests have proved already of considerable practical value.—*Engineering*, April 12th, 1901, pp. 463-68. (Ill.)

Steel Structures.—*Constructional Steelwork, as applied to Building.* This is a paper read by Mr. Archibald D. Dawnay, A.M.Inst.C.E., before the Bristol Society of Architects, in which the author, avoiding as much as possible all purely problematic and mathematical considerations, gives a review of the history and gradual development of steel construction, and draws conclusions of practical interest from the data of experience.—*Builder*, April 20th, 1901, pp. 385-90.

2. Miscellaneous.

British Architecture.—*The Eighteenth Century Architecture of Bath.* This is a paper read by Mr. M. A. Green, before the Architectural Association, in which the author deals mainly with the period between the years 1727, when the elder Wood came to Bath, and 1781, the date of the death of his son.—*The Builder*, April 27th, 1901, pp. 407-11.

Italian Cities.—*Some Cities of Modern Italy.* Brescia. The article deals with the most interesting architectural features of the small, but clean and flourishing town of Brescia, which mostly are specimens of projected and partly executed reinstatements of some ancient buildings. —*Builder*, April 20th, 1901, pp. 381, 382.

Renaissance Architecture.—*Sanmichele and his Work.* By J. Stuart Syme. Abstract of a paper read before the Edinburgh Architectural Society, in which the author endeavours to determine the position which Sanmichele occupied with regard to the Italian Architectural Revival, and passes in review the most important work of this well-known architect, arriving at the conclusion that among the high artistic qualities of Sanmichele perhaps most noteworthy is his very great power of restraint.—*Builder's Journal*, April 27th, 1901, pp. 214-17. (Ill.)

Romanesque Architecture.—*The Classification of Romanesque Architecture.* Digest of a paper by Mr. Francis Bond, M.A., read at the Royal Institute of British Architects, in which the author points out the difficulty of giving a clear definition of the great style of architecture that succeeded the Roman and anteceded the Gothic. Although classifications of the Romanesque exist already, the author thinks that they are not quite adequate, and endeavours to find a wider term based upon the main facts of plan and structure.—*British Architect*, April 26th, 1901, pp. 291, 292.

CIVIL ENGINEERING.

1. Bridges.

Bridge-Building.—*A Novel Method of Bridge Erection without Falsework.* Extracts from a recent paper by Mr. C. F. V. Jackson, read before the Institution of Civil Engineers, in which the author describes the design and construction of a railway bridge in Queensland, Australia, and gives an account of the ingenious manner in which the use of falsework was dispensed with.—*Engineering News*, Feb. 21st, 1901, p. 135. (Ill.)

—— *Low Level Concrete Bridge on the Mary River, Maryborough, Queensland.* By Alfred Barton Brady. Abstract of a paper read before the Institution of Civil Engineers, giving a fairly full description of the bridge and the manner in which it was built.—*Engineering News*, Feb. 14th, 1901, pp. 126-28. (Ill.)

2. Canals, Rivers and Harbours.

Canals.—*Method of Cementing the Irrigation Canals of the North Riverside and Jarupa Canal Co.* By E. Duryce, in which the author describes the manner in which the cementing was performed. —*Engineering News*, Feb. 21st, 1901, p. 140.

Dredges.—*Sea-Going Hydraulic Dredges for the East Channel Improvement, New York Harbour.* The article describes two dredges which are among the largest and most up-to-date dredges ever built in the United States.—*Engineering News*, Feb. 14th, 1901, pp. 118, 119.

3. Miscellaneous.

Surveying.—*Controlling a Topographical Survey.* By William C. Bunnel. The author passes in review the various methods of surveying and their advantages and drawbacks, recommending one as more suitable than most of the others, as he endeavours to show with reference to an actual case.—*Engineering News*, Feb. 14th, 1901, pp. 115-17. (Ill.)

Surveying.—*The Topographic Mapping of the United States by the U.S. Geological Survey.* By H. M. Wilson. This is an introductory article anteceding two similar ones dealing concisely with the progress made, first in the topographic mapping; secondly, with the primary triangulation and precise levelling; and thirdly, with the hydraulic and forest surveys of the various bureaus of the United States Government.—*Engineering News*, Feb. 7th, 1901, pp. 91, 92.

ELECTRICAL ENGINEERING.

1. Electro-Chemistry.

Accumulators. — *The Resistance of Lead Plate Accumulators and its Distribution between the Two Electrodes.* By F. Dolezalek and R. Gahl. The authors give an interesting description of their inquiry, and numerous experiments, together with tabulated results and diagrams.—*Zeitschrift für Elektrochemie*, Jan. 24th, pp. 429-33, and Jan. 30th, pp. 437-41.

Autoxidation. — *Autoxidation and its Connection with the Theory of Ions.* By F. Naber. This is a very interesting contribution, consisting of an inquiry into the theory of ions, based upon an analysis of the electro-chemical action of galvanic elements.—*Zeitschrift für Elektrochemie*, Jan. 31st, 1901, pp. 441-48.

2. Electric Lighting.

Arc Lamps. — *Arc Lamp Standardisation.* By Harold Almert. Abstract of a paper read before the Chicago Electrical Association, in which the author dwells on the difficulties of photometrical inquiries regarding arc light, and points out that the measurement based on candle-power is totally unsuited for the purpose.—*Western Electrician*, Feb. 2nd, p. 88.

3. Power.

Alternating Currents.—*Alternating Current Systems.* By N. S. Meyer, A.M.A.I.E.E. Rugby. The author, after pointing out that in laying out alternating-current systems the engineer finds a much larger field for variations than in direct-current work, discusses the various problems on the basis of experience gained in the United States and on the Continent, with due allowance for modifications necessary in English practice, owing to the restrictions made by the Board of Trade regulations and rules laid down by the various municipalities.—*Engineering*, March 29th, 1901, p. 395; April 5th, pp. 431, 432; April 19th, pp. 495-97.

Cables.—*High Tension Cables.* Comments on an interesting paper on the above subject, read by Mr. Mervyn O'Gorman, before the Institution of Electrical Engineers, in which the author discusses many points having an important bearing on schemes of electric power transmission, and endeavours to show that, contrary to current belief, it is often cheaper with high tension current to use more copper and less thickness of insulation, and that in such cases the highest practical voltage is not necessarily that leading to the greatest economy of capital, a lower often being more profitable from this point of view.—*Engineering*, March 24th, 1901, p. 379.

Converters.—*Synchronous Converters.* By W. E. Goldsborough. Abstract of a paper read before the North-Western Electrical Association, in which the author explains the apparatus and the theory on which it is based, together with the working and management.—*Electrical Review* (New York), Feb. 2nd, 1901, p. 86, and Feb. 9th, pp. 102, 103.

Power and Light.—*Power and Light for the Machine Shop and Foundry.* This is the title of a paper by Mr. Forrest R. Jones, of Worcester, Mass., U.S.A., read before the American Society of Mechanical Engineers, in which the author deals with plants intended for the supply both of power and light on the basis of a description of two establishments, the one consisting of a group of entirely separated buildings, while in the other the floor-space is nearly all in an L-shaped building, partly of four stories and partly of three, both establishments producing chiefly iron machinery, and therefore offering a good opportunity for comparison and for an inquiry regarding the plant best suited for each special case.—*Engineering*, March 1st, pp. 287, 288.

Power Transmission. — *Polyphase Sub-Station Machinery.* By A. C. Eborall. This is the title of a paper read before the Institution of Electrical Engineeers, in which the author, after explaining the general idea underlying the erection of polyphase sub-stations, describes some of the main features of the working, and compares the various types of machinery.—*Engineering*, March 22nd, pp. 387-91, and March 29th, pp. 403-7.

4. Telegraphy and Telephony.

Telephones. — *The Telephone and Auto-Commutator.* The article deals with a system recently introduced into France, permitting subscribers to make direct connection with each other without having to ring-up the central office, and the author explains the principle on which the system is based. — *Scientific American*, Feb. 9th, 1901, pp. 85, 86. (Ill.)

5. Miscellaneous.

Magnetic Observatories.—*The Magnetic Observatory of the United States Government.* The article describes the buildings of the establishment and their scientific equipment.—*Western Electrician*, Feb. 9th, 1901, pp. 96, 97. (Ill.)

MARINE ENGINEERING.

1. Merchant Vessels.

Atlantic Liners. — *New North German Lloyd Atlantic Steamer "Kronprinz Wilhelm."* Description of a new German liner bearing the above name, which was launched on March 30th from the famous Vulcan Works. It has been built for the North German Lloyd, and is slightly larger than *De Kaiser Wilhelm*, of the same company, but 20ft. shorter than the Hamburg-American liner *Deutschland*, and is built of German steel. The contract speed is said to be 22 knots, which, judging from the excellent work done by the Vulcan Works on previous occasions, will probably not only be reached, but exceeded.—*Engineering*, April 12th, 1901, p. 44.

—— *The White Star Liner "Celtic."* Concise description of the great Atlantic liner launched on the 4th of last month from the yard of Messrs. Harland & Wolff, of Belfast, which for the time being has the distinction of being the largest ship afloat in point of gross tonnage and displacement tonnage, though in length, and above all in speed, she is excelled by the *Oceanic*, and will be excelled in the near future by the *Wilhelm der Zweite*, which is in the course of construction at the Vulcan Works, near Stettin, Germany, and which is larger than both these ships, and promises to outstrip in speed all ships ever built.—*Engineering*, April 12th, p. 472.

Merchant Marines.—*A Brief Sketch of the Origin and Development of the World's Shipping.* By Laurence Irwell. The article consists of an interesting and instructive review of the gradual development of the merchant marines and the carrying trade of the various nations.—*Marine Engineering*, Feb., 1901, pp. 44-46.

2. Pleasure Craft.

3. Equipment and Machinery.

Signalling.—*Submarine Signalling.* By Arthur J. Mundy. Description of a signalling device designed by the author and Prof. Elisha Gray, by means of which signals can be sent to a distance of twelve miles.—*Scientific American*, Feb. 2nd, 1901, pp. 73, 74. (Ill.)

4. Miscellaneous.

Rolling of Ships.—*An Instrument for Measuring the Rolling of Ships.* By Mr. A. Mallock. Reprint of a paper read before the Institution of Naval Architects, in which the author, after pointing out that the measurement of the rolling of a ship does not consist in merely measuring the angle by means of a pendulum, but is far more complicated, describes an ingenious instrument giving direct reading, and being an improvement upon the method of observation with battons.—*Engineering*, March 29th, 1901, pp. 407-10.

Shipbuilding.—*Messrs. Yarrow & Co.'s New Works.* Description of the new premises of this well-known company, whose works for building light draught steamers, torpedo craft, launches, and other special vessels, at Poplar, have for some years been too restricted for their constantly increasing business, and who have

erected and equipped a number of new buildings in the place of the old yard of Messrs. Westwood, Baily & Co., thus creating an up-to-date establishment described in this article.—*Engineering*, April 5th, 1901, pp. 441, 442. (Ill.)

Vibration.—*The Vibration of Steamers.* By Herr Otto Schlick. Abstract of a paper read before the Institution of Naval Architects, in which the author discusses the causes of vibration and explains the result of a series of experiments made by him on the Atlantic liner *Deutschland*, during her trial trip in June, 1900.—*Engineering*, March 29th, 1901, pp. 721-27.

MECHANICAL ENGINEERING

1. Boilers, Furnaces and Fuel.

Boilers.—*Steam Boilers and Electric Stations.* The author of the article passes in review the various points to be taken into consideration in the selection of a type of boiler suitable for a given pressure of steam, and the working principles connected with the problem.—*Electrical Review*, Feb. 15th, 1901, pp. 266-68.

Water-Tube Boilers.—*The Thornycroft-Marshall Water-Tube Boiler.* Description of an improved type of water-tube boiler in operation at the works of J. I. Thornycroft, at Chiswick. The boiler is not designed for what is known as "express" purposes, such as torpedo-boat practice, nor is it intended to supersede the older Thornycroft design of small-tube boiler, but it possesses what appear to be considerable advantages over the Belleville type, and its builders are sanguine regarding its success.—*Engineering*, March 15th, 1901, pp. 333, 334.

—— *On a Form of Double-Tube Boiler.* By Mr. John Irving. Description of the construction and performance of a boiler, differing very much from any other type, and built by the author in conjunction with Mr. K. D. Noble. According to his statement this boiler has been very successful, having been in continuous use for over three years without showing any signs of deterioration.—*Engineering*, April 12th, 1901, pp. 474, 475. (Ill.)

—— Interim Report of the Committee appointed by the Admiralty in August last to inquire into the suitability of various types of marine boilers for naval purposes.—*Engineering*, March 15th, 1901, p. 335.

2. Compressed Air.

3. Engines and Motors.

Automobiles.—*Hobson Two-Wheeler Electric Vehicle.* Short description of a vehicle consisting of a seat and carriage frame, suspended between two wheels of unusually large diameter, the propelling power being derived from motors concealed in the hubs of the wheels. *Western Electrician*, Feb. 23rd, 1901, p. 129. (Ill.)

—— *New Electric Vehicle Service Proposed for Chicago.* The article gives the outlines of a project for the establishment of a low-power omnibus and cab service for Chicago.—*Western Electrician*, Jan. 26th, 1901, pp. 63, 64. (Ill.)

Engines.—*The Diesel Engine.* Description of the first British-built engine of the Diesel type (of which there are already 130 in use in the United States and on the Continent) recently completed by Messrs. Scott & Hodgson, Ltd., of Guide Bridge, Manchester.—*Engineering*, March 20th, 1901, pp. 419-21. (Ill.)

—— *On a New Assistant Cylinder.* By Mr. David Joy. This is the title of a paper read by Mr. Joy, in which the author, who ten years ago inaugurated the use of what is known as "Steam Assistant Cylinder" for valve gear, describes a new and improved form of the machinery designed by him.—*Engineering*, April 5th, 1901, pp. 442-44.

—— *Balancing Engines.* This is a paper by Professor W. E. Dalby, M.A., B.Sc., read before the Institution of Naval Architects, in which the author refers to an earlier paper on the subject read by him in 1899 on the balancing of engines, and confines himself to a discussion of the problem of balancing reciprocating masses amongst themselves, taking into account the vibration of the simple harmonic motion caused by the connecting rods.—*Engineering*, April 5, 1901, pp. 457-59; April 12, pp. 490-92.

4. Power and Transmission.

5. Machine Works, Shop and Foundry.

Forging Press.—*Hydraulic Forging Press.* Short note, giving dimensions of a large forging press, constructed recently by Messrs. L. H. Brener, Schumacher & Co., of Kalk, Cologne, which is operated at a maximum pressure of 1,202,000 kilogrammes—*i.e.* 1,181 tons. The note is accompanied by an illustration.—*Engineering*, April 19th, 1901, p. 501.

6. Tools.

Machine Tools.—*Electrically-driven Drilling Machine.* Description of a drilling machine built by Messrs. Mather & Platt, Ltd., of Salford, Manchester, with the special object of providing a tool convenient for drilling operations, where the expense of carrying the tool to the work is less than that of carrying the work to the tool. The machine described is entirely self-contained, having no connection with any outside apparatus excepting the electrical lead. The motor employed is of the Mather-Platt two-pole enclosed type, capable of developing 2-h.p. at 800 revolutions per minute, and is connected to the switch by a flexible cable.—*Engineering*, April 26th, 1901, p. 553.

—— *Armature Plate Machines.* Concise account of three machines of modern type, constructed by Messrs. Taylor & Challen, Ltd., of Birmingham, intended for dealing with armature stampings for dynamos and motors, which, being turned out in considerable number, may be dealt with more economically if treated by machine tools.—*Engineering*, April 19th, 1901, p. 507.

—— *Crank Bending Machine.* Short description of a machine constructed by Messrs. Dent & Holt, Ltd., of Bridge End Works, Burnley, for forming cranks of solid bars of iron, and also forming collars on shafts out of the solid bar.—*Engineering*, April 26th, 1901, p. 538. (Ill.)

Tools.—*Hydrostatic Tools in Railway Service.* By George L. Gillon. The author gives a concise account of the various types of hydraulic tools at present in use, including shop jacks, wrecking jacks, car wheel presses, crank pin presses, punches, and rail benders.—*Engineering News*, Feb. 7th, 1901, pp. 94-96. (Ill.)

MINING AND METALLURGY.

1. Coal and Coke.

Coke Industry.—*The Coke Industry of the United States.* Digest of the annual report on the production of coke in the United States in 1899, just published. The digest contains numerous points of interest regarding a production that exceeded over 19½ million tons, valued, at an average, at 1 dol. 76 cents per ton.—*Iron and Coal Trades Review*, April 19th, 1901, p. 811.

Whitehaven Collieries.—*Improvements at the Whitehaven Collieries.* The article deals with a number of collieries that possess unique and exceptionally interesting features, especially as regards the extensive area of under-sea workings and the system of rope haulage in which over 30 miles of steel rope are in use. The bulk of the article is devoted to the so-called William Pit, in which the cord and pillar system until recently in use was superseded by different methods of working.—*Iron and Coal Trades Review*, April 19th, 1901, pp. 823, 824.

2. Copper.

Copper Production.—*Leaching Copper Ores by Sulphuric Acid.* By E. P. Jennings. Abstract of a paper read before the Canadian Mining Institute, in which the author gives the results of his inquiry into a unique process of leaching copper ores by the use of sulphuric acid, which has been patented by James W Neill, of Salt Lake, Utah, U.S.A.—*Engineering and Mining Journal*, March 30th, 1901, p. 460.

Copper Mining.—*Arizona Copper Mining Conditions.* The article refers to a summary of the returns for 1900, dealing with the copper production of Arizona, which, for various reasons, among them the coal strikes in Colorado and the burning down of the smelting works of the Detroit Copper Company in June last, show a de-

crease in production as compared with that of 1899.—*Engineering and Mining Journal*, April 13th, 1901, pp. 456, 457.

3. Gold and Silver.

Chlorination.—*Chlorination Mills.* By Prof. Arthur Lakes. The author deals mainly with mining methods in use in the Cripple Creek District in Colorado, where it was found at an early date the ordinary stamp and concentrating mill did not suit the character of the ore, and both the cyanide and the chlorination have since been introduced and are holding their own. The chlorination process as practised in the Cripple Creek District is the typical barrel process.—*Mines and Minerals*, March, 1901, pp. 337-39. (Ill.)

Gold Mining.—*Gold Dredging.* By A. C. Perkins. Abstract of a paper read before the New South Wales Chamber of Mines, in which the author describes the dredges and the methods of working thick beds of wash on the Molyneux River, in New Zealand.—*Mines and Minerals*, March 1901, p. 350.

Silver Mining.—*Saving Slimes.* By W. C. Clark. The author describes a number of experiments made with the object of recovering values which formerly went to waste in tailings from the concentrators of lead-silver ore.—*Mines and Minerals*, March 1901, pp. 343, 344.

4. Iron and Steel.

Furnace Slag.—*Cement from Furnace Slag and Limestone.* The short article on the subject contains a concise description of a method devised by Messrs. Lothbury & Spackman, consulting engineers, of Philadelphia, for making cement, which has been in use since 1897 in the works of the Clinton Cement Company, of Pittsburg, Pennsylvania. The process consists of a proper combination of slag and limestone, having from 94 to 96 per cent. of carbonate of lime in it.—*Iron and Coal Trades Review*, April 12th, 1901, p. 758.

Iron Manufacture. *Some Applications of the Wetherill Process of Magnetic Separation.* Translation of a paper published in the *Bulletin de la Société de l'Industrie Minérale*, read before the International Congress on Mines and Metallurgy at the time of the late Paris Exhibition, in which the author, Mr. Smits, of Düsseldorf, describes the Wetherill process of magnetic separation. — *Engineering and Mining Journal*, March 30th, 1901, pp. 399, 400.

Iron Smelting. — *Electric Furnace for Smelting Iron.* Translation from the *Echo des Mines et de la Metallurgie*, describing a process for the electric smelting of iron patented by the French Electro-Metallurgical Society of Froges. — *Iron and Coal Trades Review*, April 19th, 1901, p. 823.

Pig Iron.—*Pig Iron Production in Canada.* Summary of the statistics collected by the American Iron and Steel Association, which since 1894 has included Canada in its reports, showing that in 1900 the quantity of pig iron produced in the Dominion was less by 7,987 tons than in 1899. — *Engineering and Mining Journal*, March 30th, 1901, p. 396.

5. Mining and Mining Methods.

European Mining Methods.—*Electrically operated Mines in Europe.* By Frank C. Perkins. The author deals mainly with the electrical equipment of mines, such as electrical mining pumps, electrically-driven ventilating fans, etc., and selects two mines as typical examples—namely the Ferdinandsgrube, equipped by Messrs. Siemens & Halske, and the B. Karwin Mine, both in Silesia.—*Engineering and Mining Journal*, March 30th, 1901, p. 402.

Mine Dams.—*Erection of Mine Dams at Pribram.* The article is a digest of a contribution by Mr. Fr. Mladek, published in the *Oesterreichische Zeitschrift für Berg und Hüttenwesen* recording the experience gained with a novel method in the Pribram Mines in Bohemia, and contains various points of interest for mining engineers.—*Colliery Guardian*, March 15th, 1901, p. 569.

Mining Methods.—*Mining Practice at Rossland, British Columbia.* The article deals mainly with the method of development used at the War Eagle and Centre Star Mines at Rossland, which, though a great number of the miners there were experts and had had previous experience in mining at Butte, Montana, and elsewhere, offered geological features that required radically differing methods of development from those practised at Butte.—*Mines and Minerals*, March, 1901, pp. 363-67.

Shaft-Sinking Drill.—*The Haniel and Lueg Shaft-Sinking Drill.* This is a description, translated from an article in the *Organ des Vereins Bohrtechniker*, of the new bit designed by Messrs. Haniel and Lueg, of Düsseldorf, which is a great improvement upon the ordinary types used in drills for sinking shafts, which are liable to have their peripheral teeth damaged by lateral pressure.—*Colliery Guardian*, April 19th, 1901, p. 170.

6. Miscellaneous.

Canadian Mining.—*The Mineral Production in Canada in 1900.* This is a digest based upon advance proofs of the summary statement of the Geological Survey of Canada, as prepared by the Section of Mineral Statistics, under the charge of Mr. Elric Drew Ingale, showing a large increase in the total production.—*Engineering and Mining Journal*, April 6th, 1901, p. 301.

Gas Producer Plant.—*Mond Gas Producer Plant.* The article deals with the first electrical station established in England with the special object of supplying power in bulk to large manufacturers. The owners are the Trafford Power and Light Supply Company, Ltd., Manchester, and their station is the first also in which a gas-producer plant has been laid down for producing gaseous fuel, of the Mond type, for boilers. Moreover, the Trafford Power Works will not only distribute electric energy, but also Mond gas for heating purposes.—*Colliery Guardian*, April 4th, p. 740.

Precious Stones.—*Australian Gem Stones.* This is a communication contributed by Messrs. Claremont & Ward, experts in gems, of 38, Conduit Street, London, giving a short outline of the character of gems found in Australia.—*The Australian Mining Standard*, Feb. 7th, 1901, p. 197.

MUNICIPAL ENGINEERING.

1. Gas Supply.

Coal Gas.—*The Enrichment of Coal Gas.* This problem formed the subject of a technical discussion at the annual meeting of the Manchester District Institution of Gas Engineers this year, which was introduced by a short paper by Mr. R. Hooton, Ashton-under-Lyne, who formulated a number of essential questions regarding the method and effect of enrichment of gas by benzol and carburine. He was followed by Mr. Wilfred Irwin, an expert on the subject; Mr. John Crew, who gave the result of some experiments made at Blackpool; Mr. Samuel Glover, St. Helens, who pointed out that the success of enrichment depended on the conditions, and quoted passages referring to the problem from the works of Professor Lewes; Mr. Brearley, of Longwood, who gave information regarding the cost of benzol enrichment; Mr. H. Kendrick, of Stretford, who uses only cannel for enrichment; and Mr. P. N. Ritson, of Kendal, who dwelt on the importance of the burner to be used with enriched gas, and gave an account of experiments made by Mr. Stonhouse, of Rochdale, with Manchester gas.—*Gas World*, March 16th, pp. 402-5.

Gas Engineering.—*Mr. Corbet Woodall's Presidential Address.* The report here given of Mr. Woodall's presidential address delivered at the meeting of the Southern District Association of Gas Engineers and Managers, on March 14th, gives a very full account of an exceedingly interesting lecture touching upon many subjects of importance for all interested in gas manufacture, such as electric lighting *v.* gas lighting; the remunerativeness of gas engineering; technical education and trade unionism; London as the worst lit capital in Europe—suggestions for improvement, relative costs of lighting London, Paris, and Berlin; advantages and dangers of a sliding scale, the coal and oil markets; the plan of carburetted water gas, etc.—*Gas World*, March 16th, pp. 394-98.

Gas Managers.—*Wanted a Gas Manager.* By one of the applicants. Under the above title is published a

very instructive communication, showing that in the majority of cases such advertisements are published merely to satisfy the law, the post having been filled already by a person agreeable to the Board; that "progressive" young men are not wanted, as progress does not suit those who have the appointment to give, and that consequently it is more important to study the local conditions than the latest discoveries in science.—*Gas World*, April 13th, pp. 544-45.

Gas Works Tests.—*Some Analytical Tests made in a Gas Works Laboratory.* This is the title of a paper summarized here, in which Mr. L. G. Barber, of Salford, described, at the meeting of the Manchester and District Junior Gas Association, the efficient equipment of a gas works laboratory and a number of important tests that should be made there, such as tests for ammonia, for sulphur and CO_2, and commented on testing new oxide, estimating ammoniacal liquor, tests for sulphate and spent liquor, the estimating of cyanogen, calorimeters, etc.—*Gas World*, March 16th, 1901, pp. 405, 406.

2. Sewerage.

Sewage.—*Glasgow Sewage Purification.* By Dr. John Glaister. Abstract of a paper by the author, who occupies the chair for Forensic Medicine and Public Health at Glasgow University, read at a recent meeting of the Philosophical Society, in which he described what was being done in Dalmarnock Works, designed by the late Mr. Alsing, and consisting of a combined scheme of precipitation and filtration, and drew attention to the gigantic dimensions of the Glasgow sewage system.—*Public Health Engineer*, April 6th, 1901, p. 288.

Sewage Disposal.—*The Proposed Wanwatosa Sewage Disposal System.*—Comments on a septic tank system, designed by Mr. John W. Alvord, recently approved by the Wisconsin Board of Health, the initial capacity of which is to be 60,000 gallons per day, and which is to be introduced into the city of Wanwatosa, Wisconsin, U.S.A.—*Engineering Record*, March 2nd, 1901, p. 198.

Tunnelling.—*Hydraulic Shield Tunnelling on the Melbourne and Metropolitan Sewage System.* Abstract of a paper by George Henry Dunlop, read before the Victorian Institute of Engineers, describing the above method of tunnelling in connection with the construction of a number of small sewers, and the new method of lining them, adapted to the great variety and quantity of soft ground that it was necessary to traverse.—*Engineering News*, Feb. 7th, 1901, pp. 106-8. (Ill.)

3. Streets and Pavements.

4. Water Supply.

River Purification.—*Self Purification of Polluted Water-courses.* The contribution consists of extracts from a report, by Arthur M. R. Reynolds, M.D., Commissioner of Health, Chicago, containing demonstrations of the effective self-purification of streams through natural bio-chemic processes—a proposition which, as the author says, within a decade was regarded by water analysts as untenable, while the results recently obtained by three independent investigators corroborate the assertion made by Dr. Reilly in 1886, that the waters of the Illinois and Michigan Canal and the Desplaines and Illinois Rivers so far purified themselves during June, July, and August, 1886, that all traces of Chicago sewage pollution were lost in a flow of less than 50 miles.—*Engineering Record*, March 16th, 1901, pp. 250-52.

Siphons.—*A Successful Siphon.* Abstract of a paper by Mr. Robert S. Hale, read before the Boston Society of Engineers, describing the solution of a problem occurring in a small water-supply plant. This solution consisted in the employment of an air-tight siphon at a cost of about 250 dols., as against a cost of several thousand dollars which would have been incurred if the pipes had been laid to grades, or as against less efficient service together with an annual cost of 100 dols. if an air chamber had been provided and kept free of air by a pump.—*Engineering Record*, March 9th, 1901, pp. 222, 223.

Water Pollution.—*Proposed Water Pollution Legislation in Indiana.* The article discusses the various provisions and proposals in two bills before the Indiana Legislature, both of which are aiming to give to the State Board of Health a considerable power to deal with water-pollution and its prevention.—*Engineering News*, Feb. 14th, 1901, p. 120.

Water Purification.—*Removal of Iron from the Water Supply of Superior.* After a short outline of the water supply, the author describes the plant in use at present, including the filter beds, the clear water reservoir, the aërator, etc.—*Engineering News*, Feb. 21st, 1901, pp. 141-44.

Water Supply.—*The Metropolitan Water Supply.* This is a digest of the report on the condition of the Metropolitan water supply during January, 1901, by the water examiner appointed under the Metropolis Water Act, 1871.—*Public Health Engineer*, April 13th, 1901, p. 306.

Waterworks.—*The Burrator Waterworks for the Water Supply of Plymouth.* Abstract of a paper by Edward Sandeman, M.Inst.C.E., read before the Institution of Civil Engineers, in which the author, after calling attention to the antiquity of the Plymouth waterworks, which date from the year 1590, describes the waterworks authorised by an Act of Parliament in 1893. The drainage area comprises 5,360 acres. The Burrator reservoir is formed by two dams, one of masonry across the narrow gorge through which the River Meavy flows; the other of earthwork, lying between the two hills, Sheepstor and Burrator. The water, with a greatest depth of 77 ft., covers an area of 117 acres, the quantity impounded amounting to 657,000,000 gallons.—*Public Health Engineer*, April 13th, p. 305.

5. Miscellaneous.

Garbage Disposal.—*Some Financial, Political and Sanitary Phases of Garbage Disposal.* The article contains an account of a garbage furnace to be tested at one of the electric lighting stations at Chicago, and comments on the various aspects of the subject.—*Engineering News*, Feb. 14th, 1901, pp. 120, 121.

—— *The Garbage Crematory at Waterbury, Conn.* Description of the new type of crematory at Waterbury, Connecticut, U.S.A., erected by the Bridgeport Boiler Works Company for Mr. H. M. Rigney, who has a five-year contract for the disposal of the garbage of Waterbury, Conn.—*Engineering Record*, March 16th, 1901, pp. 260, 261. (Ill.)

NAVAL AND MILITARY ENGINEERING.

1. War Vessels.

Fast Vessels.—*A Design for a Fast Scout.* This is the title of a paper by Rear-Admiral G. C. P. Fitzgerald, read at the spring meeting of the Institution of Naval Architects, in which the author describes a vessel planned by him, which is to be 3,800 tons, 400 ft. long between perpendiculars, 44 ft. beam, with a draught of 14 ft. with her normal coal supply on board, while there will be two screws, and the collective horse power is to be 16,000.—*Steamship*, May, 1901, p. 406.

Marine Engines.—*Machinery for the New U.S. Battleships and Armoured Cruisers.* The article gives a description of some very powerful engines, and the thoroughly modern equipment of the vessels.—*Marine Engineering*. Feb., 1901, pp. 53-59. (Ill.)

Submarine Boats.—*Submarine Boats for the British Navy.* Description of the improved *Holland*, submarine boat, of which five are being built by Messrs. Vickers, Sons & Maxim for the British Navy, accompanied by a sectional drawing.—*Engineering*, March, 29th, 1901, pp. 395-97. (Ill.)

—— *The Motion of Submarine Boats in the Vertical Plane.* By Captain William Hovgaard, of the Royal Danish Navy. This paper, read by the author before the Institution of Naval Architects, deals with the mathematical investigation of the problem, treating separately the laws of steady and disturbed motions.—*Engineering*, April 5th, pp. 459, 460, and April 12th, pp. 488-90.

2. Equipment.

Marine Boilers. — *The Thornycroft - Marshall Water-Tube Boiler.* Under this heading is described a new form of water-tube boiler at present to be seen in operation at the works of Messrs. J. I. Thornycroft & Co., at Chiswick. The boiler described is said to work satisfactorily so far as the regulations laid down by the Admiralty are concerned, but, as the writer of the article remarks, it will, of course, have to be tested in actual service afloat ere this statement can be accepted. Its chief merit appears to be that it maintains an unaltered efficiency for long periods of time.—*Engineering*, March 15th, 1901, pp. 333, 334. (Ill.)

3. Armour Plates, Guns, and Ammunition.

Automatic Guns. *The Army and Navy Building of the Paris Exhibition.* This instalment contains a description of the Hotchkiss semi-automatic 3-pounder, 47-millimètre calibre gun, and a short account of the exhibit of the Forges et Chantiers de la Méditerranée, consisting of small models of vessels built by them; and the exhibit of MM. Normand & Co., of Havre, the famous firm of torpedo builders.—*Engineering*, March 22, 1901, pp. 360-62. (Ill.)

Quick-firing Guns.—*The Army and Navy Building of the Paris Exhibition.* In this, the concluding portion of the contribution on the above subject, the writer devotes considerable space to the exhibit of the Forges et Acieries de la Marine de St. Chamond, the most interesting object of which was perhaps the quick-firing gun of Darmancier and Dalzon, which, as a field gun, is made in two calibres—70 and 75 millimètres (2·76 ins. and 2·95 ins.)—and in heavy and light types for each calibre. *Engineering*, March 29th, 1901, p. 397. (Ill.)

The Hotchkiss Company's Exhibit.—*The Army and Navy Building of the Paris Exhibition.* This is the first instalment of three articles, treating on the above subject, mainly devoted to the ordnance exhibits. The present instalment is exclusively devoted to the fine exhibit of the Hotchkiss Company, which was founded in France in 1875. Two of the guns—a 120-millimètre gun, with recoil mounting, and a 47-millimètre gun, with non-recoil mounting—are illustrated from photographs; and of the 37-millimètre automatic gun, as well as the 47-millimètre rapid-firing gun, with a central pivoting mount, sectional drawings occupying two full pages are given.—*Engineering*, March 15th, 1901, pp. 325-29.

RAILWAY WORKS.

1. Motive Power and Equipment.

British Locomotives.—*Modern Types of British Locomotives.* By C. J. Bowen Cooke. The author gives an interesting account of some of the most typical British locomotives and their performances.—*Cassier's Magazine*, April, 1901, pp. 449-68. (Ill.)

Express Locomotives.—*The Express Locomotives of a Great Railway.* By Chas. S. Lake. The author describes a number of fine locomotives owned by the London and North-Western Railway, notably the "Majestic," the "Hampden," the "Friar," the "Marchioness of Stafford," the "Doric," the "Queen Empress," the "William Froude," the "Jubilee," &c.—*Railway Magazine*, April, 1901, pp. 360-66. (Ill.)

New British Lines.—*The Mallaig Extension of the West Highland Railway.* The article deals with an extension line which possesses the rare distinction of combining æsthetic attractions of the greatest variety with economical and commercial advantages of the West of Scotland.—*Railway Magazine*, May, pp. 400-10. (Ill.)

2. New Projects and Lines in Construction.

American Lines.—*The Reading Belt Railroad.* Description of a line now under construction, a dependency of the Philadelphia and Reading Railway to relieve the congestion of traffic in the City of Reading, which is a long-felt want, since, as President Harris of the P. and R. R. pointed out, there is probably no double-track line that carries more traffic than the Reading main line during each autumn.—*Railway Age*, March 29, p. 383.

3. Permanent Way and Fixtures.

Railway Wharves.—*The Southern Pacific Wharf at Oakland, Cal.* Description of the reconstruction of the freight terminus at Oakland, California, of the line above-mentioned, which became necessary owing to the rapidly increasing Pacific and coast trade in sugar, coal, lumber, etc., from Columbia River and coast ports, and Hawaiian Islands.—*Railway Age*, April 5th, 1901, pp. 403, 404.

Repair Shops. — *The Wisconsin Central Repair Shops.* The article contains a description of the new repair shops at Fond-du-Lac, Wisconsin, U.S.A., erected for the Wisconsin Central Railway, which has about 900 miles of track and an equipment of about 150 locomotives, and nearly 10,000 cars. — *Railway Master Mechanic*, April, 1901, pp. 110-12.

4. Miscellaneous.

American Railways.—*American Transcontinental Railways.* By James Douglas, LL.D., Past-President Am. Inst. M.E. Parts I. and II. The first portion of this interesting contribution deals with the Union Pacific, the Central Pacific, the Denver-Rio Grande, and the Southern Pacific Railways; while the second portion gives an account of the Atchison, Topeka, Santa Fé, the Santa Fé Pacific, and the Canadian Pacific Railways.—*Cassier's Magazine*, March, 1901, pp. 323-40, and April, 1901, pp. 469-85. (Ill.)

British Railways.—*The "Greater" Western Railway.* By Fred. J. Husband. The author gives a very interesting description of the new additions which the Great Western Railway, which has already a mileage of 500 miles in excess of that of any other British line, are constructing or about to construct. Among these additions, those taken in hand comprise 140 miles, while those to be commenced shortly and authorized to be built will add another 60 miles.—*Railway Magazine*, April, 1901, pp. 301-13. (Ill.)

Mountain Railways.—*Mount Lowe and its Railway.* By Harold J. Shepstone. The author describes one of the most interesting engineering feats to be seen in the United States, namely the steep electric and cable line from Altadena, near Los Angeles, Southern California, to the Echo Mountain House, 3,500 ft. above sea-level, on top of Mount Lowe, named after Professor T. S. C. Lowe, a well-known American engineer who designed and built the cable-line. The motive power is derived from water driving water-wheels, near what is called Rubio Canyon, supplemented by gas engines, working two dynamos operating the traction cable. The grade of the incline averages 62 feet in every 100.—*Railway Magazine*, April, 1901, pp. 315-20. (Ill.)

World Famous Trains.—*The Alton, Limited.* By John Fairman, London and North Western Railway. The author gives a very interesting account of a train on the Chicago and Alton Railway, U.S.A., famous not so much for its speed as for its luxurious equipment. It consists of a United States postal car, a combination baggage and smoking car for local passengers, a combination parlour-chair car and coach for local passengers, a parlour-chair car for through passengers, free of extra charge, a café car with buffet, library and smoking compartment, and a Pullman parlour and observation car, all fitted up in the most luxurious style.—*Railway Magazine*, April, 1901, pp. 321-7. (Ill.)

Coal and Ore Handling.—*Further Economies in Coal Handling.* By John M. Goodwin. The author describes a coal-handling trestle, designed and patented by him, by means of which, if a train be made up of cars containing hard coal and cars containing soft coal, the two different kinds of material may be discharged simultaneously, each upon its own proper side of the trestle, the entire operation requiring no more time than the discharge of a single car, and being practically instantaneous.—*Railroad Gazette*, March 1st, 1901, p. 144.

Fuel.—*The Use of Liquid Fuel in Locomotives.* This is a very interesting lecture on the subject delivered by Mr. James Holden, locomotive superintendent of the Great Eastern Railway, before the International Railway Congress, 1900.—*Railway Engineer*, March, pp. 71-75. (Ill.)

STREET AND ELECTRIC RAILWAYS.

1. Trolley Lines.

Electric Power Station.—*New Power-Station and Elevated Railway System in Boston.* Full description of the elevated line in course of construction in Boston—which is to connect with the existing trolley lines laid in a subway—and an equally full account of the character and equipment of the new power-station situated within the centre of traffic. *Street Railway Journal*, March, 1901, pp. 173-85. (Ill.)

New Electric Railways.—*The Completion of the Albany and Hudson Third Rail Electric Railway.* This line, 36½ miles in length, runs from Hudson to Albany, parallel with the New York Central Railway track, and receives its power from a combined water and steam plant at Stuyvesant Falls, about 9½ miles north of Hudson. The article gives a concise description of the line and its equipment. *Street Railway Journal*, Feb. 1901, pp. 101-113. (Ill.)

Power Houses.—*New Power Houses for St. Louis Transit Co.* Short reference to the consolidation of the chief tramway lines of St. Louis, which will lead to the building of two new power stations, one of which is to distribute current at 6,000 volts, while the other will furnish continuous current by four dynamos of 2,250 kilo-watts, three of 1,500 kilo-watts, and three of 600 kilo-watts.—*Street Railway Journal*, Feb. 1901, p. 112.

Tramways.—*Notes on the Denver Tramway.* The article deals very fully with the subject, describing the despatching system, the signals being given by telephone, the splendid track, the cars in use, the use of the line for seeing the town and making pleasure trips, the power generation, the system by which the conductors pay themselves every day, and also their motor-men, and have every eighth day a day of rest, and other interesting details.—*Street Railway Journal*, Feb. 1901, pp. 113-21. (Ill.)

Street Railways.—*The Street Railway System of Lisbon.*—By F. A. Wardlaw. Description of the street railway system in the capital of Portugal, which is at present throughout electric, but had to be built with a narrow track, so as to prevent the omnibuses and carts from using it, since there exists no law prohibiting this use. The article describes this and other obstacles which were in the way of the contractors, and the present character and equipment of the lines.—*Street Railway Journal*, March, 1901, pp. 208-19. (Ill.)

2. Surface Contact Lines.

Surface Contact Systems.—*The Surface Contact System of the British Schuckert Electric Company.* Description of the above system, which has been in successful operation in Munich for considerably more than a year.—*Street Railway Journal*, Feb., 1901, pp. 159-60. (Ill.)

Third Rail Systems.—*The Safety Third Rail System in the B. and O. Tunnel.* In 1895 the Baltimore and Ohio Railway put in operation an electric service for the hauling of all trains by electric locomotives over the Belt Line, which was done to overcome the smoke feature in the tunnel, and to relieve that portion of the city which the Belt Line traverses from the noise of steam trains. At first electric locomotives were fed by trolley wires, but recently the Murphy Safety Third Rail System has been adopted, and the article describes the transformation.—*Street Railway Journal*, March, 1901, pp. 233-6. (Ill.)

3. Miscellaneous.

Electric Railway Systems.—*The Multiple Unit System.* The author inquires into the origin of the system, attributing the first claims to J. H. Darley and H. F. Parshall, and then describes in outline the Westinghouse Electro-Pneumatic Multiple Unit System of control, the Sprague Multiple System, and finally the General Electric Company's system, concluding with some general remarks on the subject.—*Traction and Transmission*, April, 1901, pp. 24-33. (Ill.)

Electric Motor-Cars.—*Electric Vehicles or Tram Cars.* By Alton D. Adams. The author enters upon an interesting inquiry regarding the comparative advantages and expenditure of electric vehicles furnished with accumulators and electric tramways driven by current furnished at central stations. He finally comes to the conclusion that *ceteris paribus* there remains an unbalanced advantage of transportation with battery vehicles, a saving of about one-half of the entire first cost, and also of one-half of the annual interest charges of present steam-car systems.—*Cassier's Magazine*, April, 1901, pp. 443-48.

REVIEWS.

The "Practical Engineer" Electrical Pocket-Book for 1901.—Manchester: The Technical Publishing Co., Ltd., 310, Whitworth St. Price 1s. net. Leather gilt, with Diary, 1s. 6d.

This neat little volume, leather-bound, with gilt edges, and printed on very thin, though strong and opaque, paper so as to reduce its bulk to a thickness of barely ½ in., contains nearly 300 closely-printed pages, and about 60 pages of squared paper, divided in sections of 1 in. and $\frac{1}{10}$ in. in size, comprising a convenient writing diary equally suitable for notes and plotting curves, has this year made its second appearance and been welcomed by the profession of electrical engineers as a very useful companion in their daily work. The contents represent a careful digest of an astonishing amount of literature, and comprise tables and working formulas referring to nearly every branch of electrical engineering, which are extremely useful for practical work and under conditions that render references to text-books impossible; while even where such literature is accessible this convenient pocket-book will hold its own, as the contents are very complete and the index well adapted to the utmost saving of time. The few slips and inaccuracies of the first edition have been, as far as we have tested the contents, carefully corrected, and the important section on "Gearing" has been revised and enlarged by additional tables, which will be extremely useful in selecting suitable wheels for reduction gear for motors, etc. Nor is this the only section to which new tables have been added, for we find in the text a new table for the proportioning of resistance frames and others for readily converting the different scales for measuring the specific quantity of liquids. In fact, the little volume appears to be quite up-to-date, and promises to acquire great popularity among the profession of electricians, as both its typographical appearance and its contents are excellent in their way.

BOOKS RECEIVED.

Motor Vehicles and Motors, by W. Worby Beaumont, Archibald Constable & Co., Ltd., 42/- net; Verbal Notes and Sketches for Marine Engineers, by J. W. Sothern, Messrs. Whittaker & Co., 3/6 net; Fergusson's Surveying Circle and Percentage Tables, by John C. Fergusson, M.Inst.C.E.; Specifications for Steel Bridges, by J. A. L. Waddell, Messrs. John Wiley & Sons, $1·25; Steam Boiler Economy, by William Kent, A.M., M.E., Messrs. John Wiley & Sons, $4; Moulder's Text Book, by Thomas D. West, Messrs. John Wiley & Sons, $2·50; Central Electrical Stations, by C. H. Wordingham, Messrs. Charles Griffin & Co., Ltd., 24/- net; Scientific Papers, Osborne Reynolds, Vol. II., Cambridge University Press, 21/- net.

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The letters F and B indicate respectively whether the Advertisement appears in the FRONT or BACK portions of the Magazine.

Name.	Page.	
Addy, George	xxix	B
Andrew Handyside & Co., Ltd.	viii of second cover	B
Ashton, Thomas A., Ltd.	lxiii	B
Askham Bros. & Wilson, Ltd.	xxxvi	B
Auto Machinery Co., Ltd.	xxiii	B
Bagshawe & Co.	lv	B
Batesmith Injector Co., Ltd.	lix	B
Bayliss, Jones & Baylis	xiv	F
Bedford Engineering Co.	xiii	F
Berry, Henry & Co., Ltd.	ii	F
Boby, R., Ltd.	iii	B
Brett's Patent Lifter Co., Ltd.	xlv	B
British Power Traction and Lighting Co., Ltd.	xxxiv	B
British Schuckert Electric Co., Ltd.	xxxv	B
Broadbent, Thos. & Sons, Ltd.	vi	F
Brownett, Lindley & Co., Ltd.	xxxviii	B
Brown & May, Ltd.	viii	F
Brush Electrical Engineering Co., Ltd.	xxxv	B
Butterfield, W. P.	xxiv	B
Campbell Gas Engine Co., Ltd.	xxii	B
Cape Asbestos Co., Ltd.	lvii	B
Champion Friction Clutch Co., Ltd.	xxi	B
Church's Organisation Bureau	xiii	F
Circular Addressing Co.	lxiv	B
Clapham Brothers, Ltd.	xlvii	B
Clarke's Crank and Forge Co., Ltd.	xxviii	B
Coulthard, T. & Co., Ltd.	xvii	B
Cresswell's Asbestos Co., Ltd.	lxiv	B
Crompton & Co., Ltd.	xli	B
Cundall, R. & Sons, Ltd.	xxi	B
Cutler, S. & Sons.	xlviii	B
Davey, Paxman & Co., Ltd.	iv	F
Davies, Geo. & Co.	xxiii	B
Davis & Primrose	xxv	B
Davis, John & Son	xxv	B
Davy, W. J.	xliv	B
Delta Metal Co., Ltd.	xlvi	B
Dempster, Moore & Co.	xxx	B
Drum Engineering Co.	lxii	B
Drysdale & Co.	xlvi	B
Edward Chester & Co., Ltd.	xvi	F
Edwards Air Pump Syndicate, Ltd.	xxvii	B
Electromotors, Ltd.	xliii	B
Ernest Scott & Mountain, Ltd.	xlii	B
Evans, Joseph & Sons	xxvi	B
Firth, Wm., Ltd.	lvi	B
Fleming, Birkby and Goodall, Ltd.	vi of second cover	B
General Electric Co., Ltd.	xl	B
Gent & Co.	xlvi	B
Gibbs, J. & Son	xliii	B
Glenboig Union Fire Clay Co., Ltd.	lxiv	B
Glover, W. T. & Co., Ltd.	iv of outer cover	B
Green, E. & Son, Ltd.	iii of second cover	F
Guest, James J.	xxxii	B
Hadfield's Steel Foundry Co., Ltd.	xxix	B
Hanseli & Co., F. L.	xxix	B
Harris Patent Feed-water Filters, Ltd.	xxiv	B
Hartley & Sugden, Ltd.	xxviii	B
Heenan & Froude	i	F
Horsfall Destructor Co., Ltd.	v	F
Hudswell, Clarke & Co., Ltd.	xviii	B

Name.	Page.	
International Pneumatic Tool Co., Ltd.	xxxi	B
Kaye, Josh. & Sons, Ltd.	lxiii	B
Lancaster & Tonge, Ltd.	viii	F
Lobnitz & Co., Ltd.	lxii	B
London Scottish Engraving Co., Ltd.	iii of outer cover	B
Luke & Spencer, Ltd.	xxxii	B
Macdonald, John & Co.	lix	B
Maclellan, P. & W., Ltd.	xxxiii	B
Manning, Wardle & Co.	xviii	B
Marshall, Fleming & Jack	xiv	B
Matthews & Yates, Ltd.	xliv	B
McInnes & Co., Ltd.	lx	B
McNeil, Chas.	xlv	B
Messenger & Co., Ltd.	lvi	B
Mirrless, Watson Company, Ltd.	xix	B
Morison Brothers	lvi	B
Moseley, D. & Sons	lxi	B
Mosses and Mitchell	vi of second cover	B
Newton Electrical Works, Ltd.	xlv	B
Oliver Typewriter Co., Ltd.	lvi	B
Oxley, Barker	lv	B
Palfreyman, W. H. & Co.	xlvi	B
Parker Foundry Co.	lxii	B
Parkinson, J.	xxx	B
Pawson & Brailsford	lxii	B
Pearn, Frank & Co., Ltd.	ii of cover	F
" " " "	i of second cover	F
Pearson, E. J. & J., Ltd.	lv	B
Pegg, S. & Son	liv	B
Phillips' Machinery Register	lix	B
Pillatt, A. E.	lx	B
Ratner Safe Co., Ltd.	lix	B
Reliance Lubricating Oil Co.	lxii	B
Richmond and Chandler, Ltd.	lii	B
Rosling, Appleby & Fynn, Ltd.	xxxix	B
Royles, Ltd.	vii of second cover	B
Ruston, Proctor & Co., Ltd.	xx	B
Rutherford, A. & Co.	xxv	B
Ryder, Wm.	xxxii	B
Salter, Geo. & Co.	lx	B
Shaw, Joseph	lv	B
Sherard Cowper-Coles & Co., Ltd.	xxxvii	B
Simpson & Bibby	xiv	F
Smith, Frederick & Co., Ltd.	lxii	B
Smith, Thos.	xxix	B
Smoke Consumer, Ltd.	iii	F
Stubbs, Joseph	liii	B
Summerscales, W. & Sons, Ltd.	liv	B
Taylor & Hubbard	viii of second cover	B
Templer and Ranoe, Ltd.	lxi	B
Thomas A. Ashton, Ltd.	lxiii	B
Tilghman's Patent Sand Blast Co., Ltd.	xxvii	B
Turner, E. R. & F., Ltd.	xxiii	B
United States Metallic Packing Co., Ltd.	lviii	B
Van der Heyde, J. Bennett	viii of second cover	B
Ward, Thos. W.	v of second cover	B
Watson, Laidlaw & Co.	v of second cover	B
Weir, G. & J., Ltd.	vii of second cover	B
West's Gas Improvement Co., Ltd.	xlix	B
Whitmore & Binyon	lxiii	B
Williams & Robinson, Ltd.	xi	F
Wilson Bros. Bobbin Co., Ltd.	l, li	B

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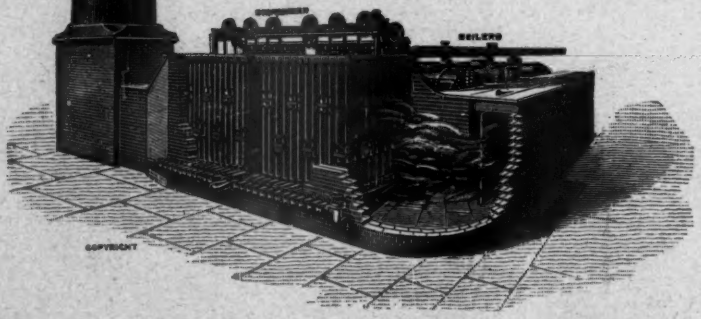

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The letters F and B indicate respectively whether the Advertisements appear in the FRONT or BACK portion of the Magazine.

Addressing Agency
Circular Addressing Co., lxvi, B.

Air Compressors
Tilghman's Patent Sand Blast Co., Ltd., xxvii, B.

Air Pumps
Edwards Air Pump Syndicate, Ltd., xxvii, B.

Arc Lamps
Crompton & Co., xli, B.
Davy, W. J., xliv, B.

Asbestos Goods
Cape Asbestos Co., lvii, B.
Creswell's Asbestos Co., Ltd., lxv, B.
Moseley, D. & Sons, lxi, B.

Ball Bearings
Auto Machinery Co., Ltd., xxiii, B.

Beltings
Fleming, Birkby & Goodall, Ltd., vi of second cover, B.

Bobbins
Wilson Bros. Bobbin Co., Ltd., l, li, B.

Boilers
Brown & May, Ltd., viii, F.
Davey, Paxman & Co., iv, F.
Dempster, Moore & Co., xxx, B.
Hartley & Sugden, Ltd., xxviii, B.
Oxley, Barker, lix, B.
Ruston, Proctor & Co., Ltd., xx, B.

Boiler Coverings and Seatings
Pearson, E. J. & J., Ltd., lix, B.

Brewers' Machinery
Boby, R., Ltd., lv, B.

Carburetted Water Gas Plant
Cutler, S. & Sons, xlviii, B.

Castings and Forgings
Hadfield's Steel Foundry Co., Ltd., xxix, B.
Hansell & Co., F. L., xxix, B.
Parker Foundry Co., lxii, B.

Chaff Cutters
Richmond & Chandler, Ltd., liii, B.

Coal-Cutting Machines
Davis, John & Son, xxv, B.

Condensing Plant
Mirrlees, Watson Company, Ltd., xix, B.
Pearn, Frank, & Co., ii of cover, i of second cover, F.
Royles Ltd., vii of second cover, B.

Constructional Ironwork
Andrew Handyside & Co., Ltd., viii of second cover, B

Corliss Gear
Turner, E. R. & F., Ltd., xxiii, B.

Cranes
Smith, Thos., xlv, B.
Bedford Engineering Co., xiii, F.
Marshall, Fleming & Jack, xiv, B.
Taylor & Hubbard, viii of 2nd cover, B.

Cranks
Clarke's Crank and Forge Co., xxviii, B.

Drawing & Surveying Instruments
Morison Bros., lvi, B.

Dredgers (Gold)
Lobnitz & Co. Ltd., lxii, B.

Drop Hammer Lifter
Brett's Patent Lifter Co., Ltd., xlv, F

Electric Mains, &c.
Glover, W. T. & Co., Ltd., xxxvii, B.

Electrical Specialities
British Power Traction and Lighting Co., Ltd., xxxiv, B.
British Schuckert Electric Co., Ltd., xxxv, B.
Brush Electrical Engineering Co., xxxv, B.
Crompton & Co., Ltd., xli, B.
Davy, W. J., xlviii, B.
Electromotors, Ltd., xxxv, B.
Ernest Scott & Mountain, Ltd., xlii, B.
General Electric Co., Ltd., xl, B.
Gent & Co., l, B.
Gibbs, J. & Sons, xliii, B.
Glover, W. T., & Co., Ltd., xxxvii, B.
Newton Electrical Works, Ltd., xiv, B.
Reeling, Appleby & Fynn, Ltd., xxxix, B.
Willans & Robinson, Ltd., xl, F.

Electro-Metallurgy
Sherard, Cowper Coles & Co., Ltd., xxxvii, B.

Emery Machines
Guest, James J., xxxii, B.
Lake & Spencer, Ltd., xxxii, B.

Engines, Gas
Campbell Gas Engine Co., Ltd., xxii, B.

Engines, Oil
Campbell Gas Engine Co., Ltd., xxii, B.
Cundall, R. & Sons, Ltd., xxi, B.
Davies, Geo. & Co., xxiii, B.

Engines, Steam
Browett, Lindley & Co., Ltd., xxxviii, B.
Brown & May, Ltd., viii, F.
Coulthard, T. & Co., Ltd., xvii, B.
Davey, Paxman & Co., iv, F.
Hudswell, Clarke & Co., Ltd., xviii, B.
Dempster, Moore & Co., xxx, B.
Manning, Wardle & Co., xviii, B.
Ruston, Proctor & Co., Ltd., xx, B.
Willans & Robinson, Ltd., xl, F.

Engravers
London Scottish Engraving Co., Ltd., iii of outer cover, B.

Extruded Metal
Delta Metal Co., Ltd., xlvi, B.

Feed Water Filters
Harris Patent Feed Water Filters, Ltd., xxiv, B.

Feed Water Heaters
Royles Ltd., vii of second cover, B.

Fire Bricks
Glenboig Union Fire Clay Co., Ltd., lxv, B.
Pearson, E. J. & J., Ltd. lix, B.

Forgings, etc.
Clarke's Crank and Forge Co., xxviii, B.

Forging Machines
Ryder, Wm., xxxii, B.

Friction Clutches
Champion Friction Clutch Co., Ltd., xxi, B.

Fuel Economisers
Green, H. & Son, Ltd., iii of second cover, F.

Furnaces
Pillatt, A. E., lx, B.

Gas Machinery
Clapham Bros., xlvii, B.
Cutler, S. & Sons, xlviii, B.
West's Gas Improvement Co., Ltd., xlix, B.

Gravel Washing Machines
Pegg, S. & Son, liv, B.

Hot Water Apparatus
Messenger & Co., Ltd., lvi, B.

Hydraulic Machinery
Berry, Henry & Co., Ltd., li, F.

Hydraulic Stampings and Forgings
McNeil, Chas., xxix, B.

Hydro-Extractors
Broadbent, Thos., & Sons, Ltd., vi, F.
Watson, Laidlaw & Co., v of second cover, B.

Indicators
McInnes & Co., Ltd., lx, B.

Injectors and Steam Fittings
Batesmith Injector Co., Ltd., lix, B.

Iron and Steel Goods
Andrew Handyside & Co., Ltd., viii of second cover, B.
Baylis, Jones & Bayliss, xvi, F.

Laundry Machinery
Summerscales, W., & Sons, Ltd., liv, B.

Locomotives
Hudswell, Clarke & Co., Ltd., xviii, B.
Manning, Wardle & Co., xviii, B.

Lubricating Oils
Reliance Lubricating Oil Co., lxiii, B.

Lubricators
Thomas A. Ashton, Ltd., lxiii, B.

Machine Tools
Addy, George, xxix, B.
Dempster, Moore & Co., xxx, B.
Guest, James J., xxxii, B.
Maclellan, P. & W., Ltd., xxxiii, B.
Parkinson, J., xxx, B.
Ward, T. W., v of second cover, B.

Manhole and Sludge Doors
McNeil, Chas. M., xxix, B.

Mining Machinery
Edward Chester & Co., Ltd., xvi, F.

Motor Vehicles
British Power Traction & Lighting Co., Ltd., xxxiv, B.
Coulthard, T. & Co., Ltd., xvii, B
Simpson & Bibby, xvi, F.

Oil Can, Seamless
Kaye, Josh. & Sons, Ltd., lxiii, B.

Organisation Bureau
Church's Organisation Bureau, xiii, F.

Packings (Metallic and other)
Bagshawe & Co., lv, B.
Lancaster & Tonge, viii, F.
Moseley, David & Sons, lxi, B.
Mosses & Mitchell, vi of second cover, B.
United States Metallic Packing Co., lviii, B
Von der Heyde, J. Bennett, viii of second cover, B.

Photo-Engravers
London Scottish Engraving Co., Ltd., iii of outer cover, B.

Pistons
Lancaster & Tonge, Ltd., viii, F.

Pneumatic Tools and Appliances
International Pneumatic Tool Co., Ltd., xxxi, B.
United States Metallic Packing Co. lviii, B.

Printers
Pawson & Brailsford, lxii, B.

Publications
Phillips' Machinery Register, lix, B.

Pumps, Air
Edwards Air Pump Syndicate, Ltd., xx, B.

Pumps, Steam
Drum Engineering Co., lxiii, B.
Drysdale & Co., xlvi, B.
Evans & Sons, Joseph, xxvi, B.
Pearn, Frank & Co., ii of cover, i of second cover, F.
Weir, G. & J., Ltd., vii of second cover, B.
Whitmore & Binyon, lxiii, B.

Rails
Askham Bros. & Wilson, Ltd., xxxvi, B.
Gillespie & Wilson, iii of outer cover, B.
Firth, W., Ltd., lvi, B.

Refuse Destructors
Horsfall Destructor Co., Ltd., v, F.

Rust Preventive
Palfreyman, W. H., & Co., xlvi, B.

Safes
Ratner Safe Co., Ltd., lix, B.

Shipbuilders, &c.
Rutherford & Co., xxv, B.

Smoke Consumers
Smoke Consumer, Ltd., liii, F

Steam Hammers
Davis & Primrose, xxv, B.

Steam Traps
Lancaster & Tonge, Ltd., viii, F.

Steel Founders
Hadfield Steel Foundry Co., Ltd., xxix, B

Stone-Breaking Machinery
Pegg, S. & Son, liv, B.

Structural Engineering
Heenan & Froude, i, F.

Sugar-Curing Plant.
Watson, Laidlaw & Co., v of 2nd cover, B

Tanks and Cisterns
Butterfield, W. F., xxiv, B.

Textile Machinery
Stubbs, Joseph, liii, B.

Tool Steel
Hadfield Steel Foundry Co., Ltd., xxix, B.
Hansell, J. L. & Co., xxix, B.

Tramway Plant
Askham Bros. & Wilson, Ltd., xxxvi, B.

Turbines
Macdonald, John & Co., lix, B.

Typewriters
Oliver Typewriter Co., Ltd., lvi, B.
Salter, Geo. & Co., lx, B.

Valves
Shaw, Joseph, lv, B.
Templer & Ranse, Ltd., lxi, B.

Ventilating Machinery, &c.
Matthews & Yates, Ltd., xliv, B.

Vulcanized Fibre
Mosses & Mitchell, vi of second cover, B.

Water-Level Indicators
Gent & Co., xlvi, B.

Wire and Wire Ropes
Smith, F. & Co., Ltd., lxi, B.

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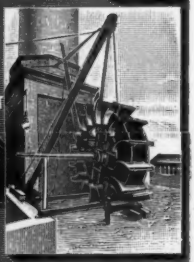

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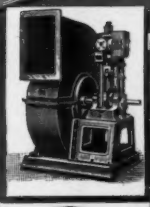

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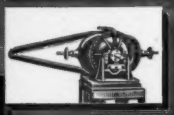

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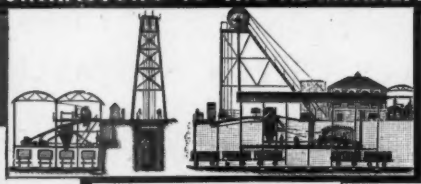

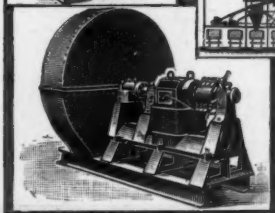

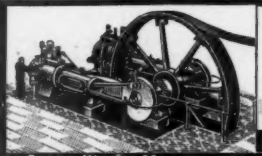

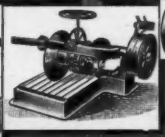

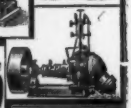

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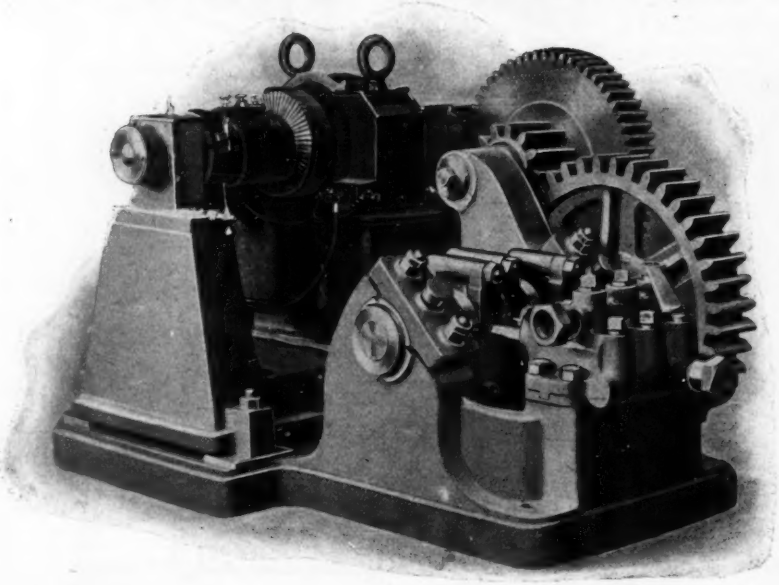

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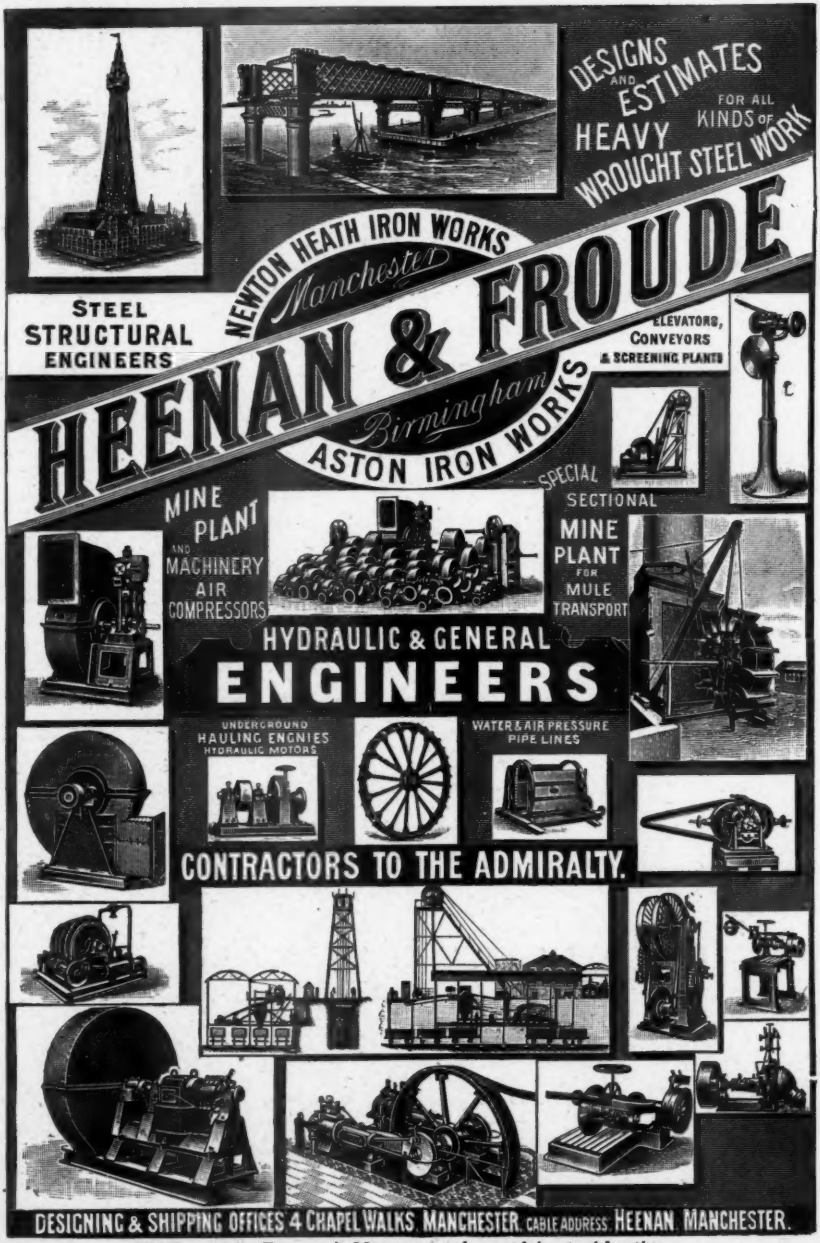
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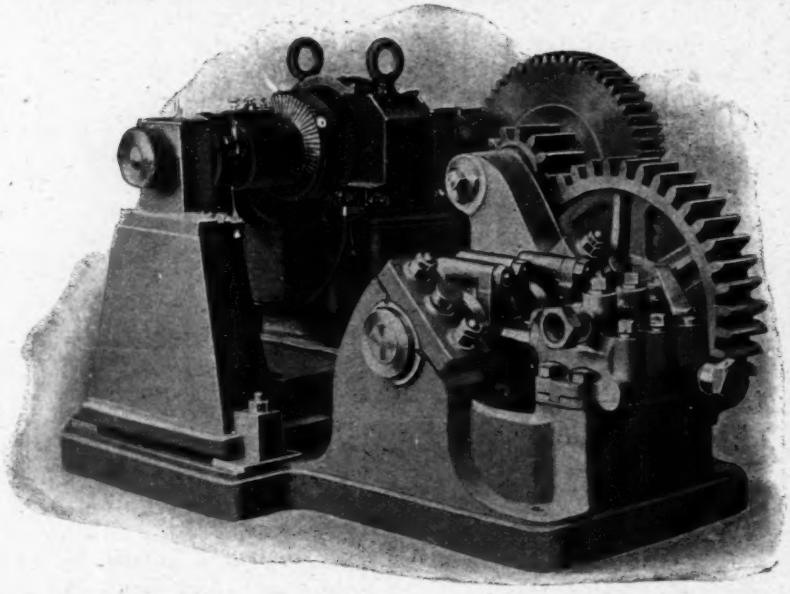

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Leading British Firms in the Engineering, Shipbuilding and Allied Industries.

☞ *To ascertain the Names of Firms Manufacturing any of the Specialities in the following List, take the numbers indicated against each name and refer to the corresponding numbers in the List of Firms on pages* xi *and* xiv.

For the benefit of the readers of this Magazine, the proprietors have organised a special department of their business, in which the Catalogues and Price Lists of the firms named in this Directory are preserved for reference. They can be consulted free of any expense at all times by subscribers to or advertisers in FEILDEN'S MAGAZINE, and any inquiries will be freely answered either by letter or personally.

This organisation possesses special facilities for securing *inside* information not otherwise obtainable. Correspondence from any part of the world will receive immediate attention, and the wants and requirements of Foreign and Colonial buyers will be catered for in a manner hitherto but imperfectly done by other agencies. The most authentic information will be vouchsafed to readers as to the merits of the respective specialities advertised.

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Agricultural Machinery... ... D3, R17, S23
Air Compressors T4
Air Propellors M27
Air Pumps B7
Arc Lamps D10
Asbestos Manufacturers... ... C7, C17, S7
Axle Boxes... ... ... F9
Bearings A15, F7
Belting C22, F7, L2, R30
Bending Machines B5,
Blowers and Fans... ... ... M27, S22
Bobbin and Shuttlemakers ... W16
Boiler Coverings C17, P8, S7
Boiler Flue Covers P8
Boiler Seating Blocks P8
Boilers B22, D3, G1, H6, M3, O4, R14, R17
Boilers, Liquid Fuel C18
Bolts, Nuts and Fastenings ... A15
Brass Founders E11, L3, S25
Brewers' Engineers B20
Bridges G7, H12, I2
Castings H2, P9, P11
Chaffcutters R15
Clutches (Friction) C6
Coal Drills and Cutters D14
Condensers & Condensing Plant B24, E11, R20
Conveyors W18
Corliss Gear T5
Cranes, &c. B27, C19, M4, S26 T6
Cranks C21
Cream Separators... ... ... W17
Disinfecting Apparatus M12
Drawing and Surveying Instruments M28
Dredgers (Gold) L7
Drop Hammer Lifter B21
Dust Baffles A1
Dynamos B26, E5, E11, M27, N3
Electric Fans E11, G5, M27
Electric Tram Cars B17, B18, B26
Electrical Apparatus and Machinery ... B14, B26, B28, C23, C15, D10, E4, E5, E11, G4, G6, N3, R17, R19, W8
Electrical Wire & Cable Makers G15
Emery and Emery Wheels ... B23, G10, L15
Engines (Steam and Loco.) ... B22, B24, C19, D3, E11, G1, H24, M5, O4, R17, W3
Engines (Gas and Oil) C3, C24, D9, M3, R2
Engraving B21, D18
Evaporators M31
Feed-water Heaters M27, R20
Feed-water Filters H20
Files and Hammers S20
Fire Bricks... ... ... G8, F8
Forging Machines & Presses ... R18
Forgings H21, M31
Fuel Economisers... ... ... G9
Furnaces H21, P12
Galvanisers... ... ... B8
Gas Lighting Engineers... ... C13, C14, G2, K3, W18
Grinding Machinery G10, L15
Hydraulic Machinery A10, B5
Hydro-Extractors... ... ... B13, M3, W17
Indicators M30
Injectors B3, M3
Iron and Steel Goods B2
Iron and Steel Works Plant ... B5
Jointings B1
Laundry Machinery M3, S23, W17
Lubricating Oil R10, W1
Lubricators... ... ... T1
Machine Tools A2, B1, B5, B23, D15, D17 M29
Metallic and other Packing ... E10, L3, M33, S7, U1, V3
Metals D11
Mining Machinery D14, E11, L7, R17
Motor Vehicles (Steam-driven) .. B28, C18, S5
Oil Cans, Lubricators and Pumps K1, T1, W7
Packing: Metallic, Asbestos, and Indiarubber E12, L3, M33, S7, U1, V3
Pipes (Steel and Iron) L12, R17
Pistons L3
Pneumatic Tools and Appliances I3, U1
Pumps C5, D12, D16, E6, E7, E11, H25, P5, R20, W7, W21
Railway Plant F9, G7, P9, W19
Refuse Destructor H21
Roller Spindle Flyer and Tool Manufacturer R18
Rust Preventive P1
Sewage Treatment S1
Screwing Tackle W7
Shear and Spring Steel S20
Shipbuilders R14, T2
Steam Fittings B3, L3
Steam and Vacuum Hammers ... D15, Y1
Steam Launches R14
Steam Navvies R17
Steam Traps L3
Steel Converters and Melters ... S20
Steel Plant B5
Sugar Machinery W17
Tanks and Cisterns B29
Textile Machinery S22, W16
Tool Steel S20
Tramway Tracks A8
Tubes L12, R17, R20
Typewriters S25
Valve Makers G16, T7
Vulcanized Fibre M32
Water Level Indicators G4
Water Purification & Softening K5, M26
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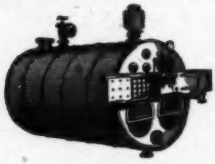

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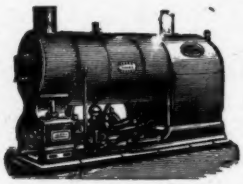

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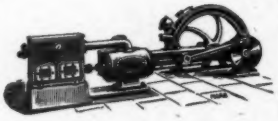

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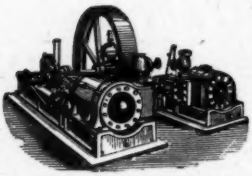

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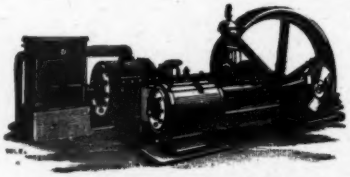

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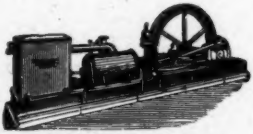

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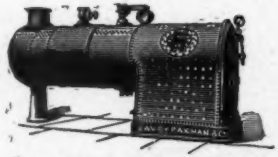

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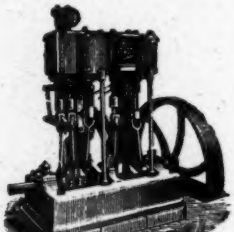

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Feilden's Magazine: Annuaire de l'Acheteur.

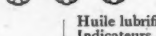
Cette liste contient, sur les pages xi et xiv, les noms et les adresses postales et télégraphiques des

Principales Maisons de Nations parlant la langue anglaise s'occupant de travaux du Génie, de la Construction de Machines et de Navires et se livrant à d'autres Industries analogues.

Avec indication sur cette page, du genre d'industrie dont chacune de ces Maisons fait sa spécialité.

☞ *Pour savoir les noms de maisons qui fabriquent quelqu'une des spécialités comprises dans la liste suivante, prendre les numéros vis-à-vis de chaque nom et chercher les numéros correspondants dans la liste des maisons, sur pages* xi *et* xiv.

Dans l'intérêt des lecteurs de ce Journal, ses éditeurs ont organisé dans leurs bureaux un service spécial pour la conservation des catalogues et prix courants des diverses Maisons figurant dans la liste, afin de pouvoir s'y reporter au besoin. Ces imprimés peuvent à tout moment être consultés, sans frais, par les abonnés du FEILDEN'S MAGAZINE et les personnes qui font paraître des annonces dans cette publication. On répond, en outre, soit par lettre affranchie, soit personnellement, à toute demande de renseignements.



Accessoires des moteurs et de chaudières E11
Acier corroyé et acier à ressorts S20
Acier à Outils S20
Agents de Brevets B18, R6
Appareils à chauffer l'eau d'alimentation M27
Appareils de chauffage M15, M27
Appareils de désinfection ... M3, M12
Appareil's de vissage W7
Appareils Séparateurs de crême W17
Automobiles B28, C18, S5
Boites à étoupe P8, S7
Boîtes à vapeur L3
Briques refractarie G8, P8
Burette d'huile K1
Carbide calcium A2
Chaloupes à vapeur R14
Chaudières B22, D3, G1, H6, M3, O4, R14, R17
Chaudières à tubes bouilleurs (Combustible liquide) C18
Chauffeurs mécaniques H21, P12
Comprimeurs d'air T4
Condenseurs E11, R20
Constructeurs de navires ... R14, T2
Convertisseurs et Fondeurs d'acier S20
Courroies C22, F7, L2, R20
Coussinets rotatoires A15, F7
Couverture pour chaudières ... C17
Dynamomètres B1, B17, B26, M27, N3, R19
Elevateurs B27, C19, H12, M4, S26, T6
Emeri et roues à emeri B23, G10, L15
Engrenage Corliss T5
Evaporateurs M31
Excavateurs à vapeur R17
Fabricants d'amiante C7, C17, E10, S7
Fabricants de bobines et de navettes W16
Fabricants d'économiseurs de combustible G9
Fabricants de Fil S11
Fabricants de rouleaux, broches et méchoirs R18
Fabricants de soupapes G16, T7
Fils et câbles électriques ... G15
Fondeurs en cuivre E11, L3, S25
Fontes H2, P9, P11
Fourneaux M12, P12
Fourniture d'acieries B5
" " et de fer ... B5
Galvanoplastie B8
Garniture métallique L3, M33, S7, U1, V3
Garniture pour tuyaux B1
Graisseurs T1
Gruffes C6
Hégice à air M27
Hydro-extracteurs B13, M3, W17
Huile lubrifiante R10
Indicateurs... ... ... M30
Ingénieurs ajusteurs d'appareils de gaz C13, C14, G2, K3, W18
Ingénieurs de brasserie B20
Injecteurs M3
Instruments de géomètre et de mathématiques A7, M28
Lampes à arc B17, D10
Limes S20
Machines agricoles D3, F17, S23
" à cintrer B5
" " draguer pour d'or ... L7
" " écrire... ... ... B8, S25, W11
" " émoudre G10, L15
" à vapeur et locomotives B17, B22, B24, C19, E11, G1, H24, L3, M5, O4, R2, R17, W3
" électriques B14, B17, B24, B26, B28, C23, D10, E4, E5, E11, G4, G6, N3, R17, R19, S12, W8
" et appareils à l'usage de filateurs P3, S22, W16
" hydrauliques B5, H12
" minières D14, H12, L7, R17
" pour buanderies ... M3, S23
" " moulins huile... M3
Matériel de chemin de fer ... B17, F9, G7, P9, W19
Matériel de raffineries H12, M3, W17
Metallurgie électrique C16
Métaux D11, P7
Moteurs à gaz et machines à huile C24, D9, H12, M3
Œuvres de forge M31
Outils A2, B5, B23, D15, D17, L4, M29, S4, S9, W19
" et appareils à vide ... I3, U1
Paliers d'essieux P9
Paliers pour Assises de chaudières P8
Perçoirs et coupeurs ou Haveurs du Charbon D14
Photographie L6
Pistons L3
Pompes C5, D12, D16, E6, E7, E11 H25, P3, R20, W21
Pompes à air E7
Ponts G7, H12
Presses à forger R18
Purification et adoucissement de l'eau K5, M26
Reservoirs d'eau B29
Souffleurs et Ventilateurs ... B22, M27
Traitement des Matières Vannes R2, S1
Tramways électriques A8, B1, B17, B18, B26
Tubes L12, R17, R20
Tuyaux en acier et en fer ... L12
Ventilateurs électriques G5, M27
Vis sans fin... ... ... H12, W18
Voitures de chemin de fer ... B17

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Vorliegende Liste an zeite xi und xiv enthält die Namen so wie die Adressen für Correspondenz und Telegramme

der hervorragendsten Englisch-sprechenden im Ingenieurwesen, dem Maschinen- und Schiffbau und den damit verwandten Industriesweigen thätigen Handels- und Fabriksanstalten.

Nebst Angabe der von denselben erzeugten resp. in den Handel gebrachten Specialitäten.

☞ *Um die Namen der Firmen, welche irgend eine der in der folgenden Liste enthaltenen Specialitäten fabriciren, zu finden, bemerkeman die jedem Namen beigefügte Nummer und suche die entsprechende Nummer in der Firma-liste, Seite* xi. *und* xiv.

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❀ ❀ ❀

Asbestwaaren Fabrikanten ... C7, C17, S7
Aufzug und Afterläuber G2, H12
Bergbaumaschinen B2, D14, H12, L7, R17
Biegemaschinen B5
Blasebälge und Ventilatoren ... M27, B22
Bogenlampe D10
Brauerei-Ingenieure B20
Brücken G7, H12
Büchsen für Aschenlagez ... F9
Centrifugal-Trockenmaschine ... B13, M3, W17
Condensatoren und Condensir-Anlagen E11, R20
Conveyers (Aufzuge) H12, W18
Corliss-Getriebe T5
Dampfbagger R17
Dampfbarkassen R14, T2
Dampfmaschinen und Locomotiven B17, B22, B24, C19, D3, E11, G1, H24, M5, O4, R17, W3
Dampfventile L3
Desinficirapparat M3
Draht-Fabrikanten S11
Dynamomaschinen B1, B17, B26, M27, N3, R19
Eisen und Stahl Röhren ... L12
Eisen und Stahlfabrik Anlagen B5
Eisenbahn-Betriebsmaterial ... B17, F9, G7, P9
Eisenbahn-Wagen B17
Elektrische Maschinen C23, B17, B24, B26, B28, C23, D10, E4, E5, E11, G4, G6, N3, P10, R17, R19, S12, W8
Elektrische Tramwagen A8, B1, B17, B18, B26
Elektrische Ventilatoren ... M27
Elektrischer Draht und Kabel ... G15
Elektrische Uhrn L9
Fabrikant von Wellen Spindeln Flyern und Werkzeugen ... R18
Feilen S20
Galvano plastiche Anlagen ... B8
Gas Ingenieure B7, C13, C14, G2, K3, W18, W20
Gasmotoren und Oelmaschinen... C24, D9, M3
Gegerbter und Feder-Stahl ... S20
Getyeidemühlen-maschinen ... R21
Gussstücke H2, P9, P11
Haken C6
Heizapparat M15, M27
Hochöfen P12
Hydraulische Maschinen ... B5, H12
Indiaktoren M30
Injektoren M3
Jauchenbehandlung R2, S1
Kessel B22, D3, G1, H6, M3, O4, R14, R17
Kessel mit Olbeheizung C18
Kesselbedeckung C17, E10, S7
Kessellagerboecke P8
Kohlenbohrer und Kohlenschneider... ... ... D14
Kohlensparer G9
Kolben L3
Krahne B27, C19, M4, S26, T6
Landwirtschaftliche Maschinen D3, R17, S23
Luftpumpen H7
Luftschiffsschrauben M27
Luftverdichter T4
Maschinen für Wäschereien ... M3, S23, W17
Maschinen und Kesselausrüstung E11
Maschinen Werkzeuge A2, A9, B5, B23, D15, D17, L4, M29, S9, W19
Maschinen zur Behandlung von Gespinsten (Geweben).. ... P3, S22, W16
Mechanische Schürer B21, P12
Messinggiesserei E11, L3, S25
Metalle A11, D11, P7
Metall- Dichtung L3, M33, S7, U1, V3
Motorwagen Automotoren ... C18
Oel-Mühlen-Maschinen M3
Olkannen K1
Patent-Anwälte B18
Pneumatische Werkzeuge und Apparate... ... ... I3, U1
Pumpen C5, D12, D16, E6, E7, E11, H25, P5, R20, W21
Reinigung und Weichmachen des Wassers K5, M26
Rohrdichtung B1
Röhren L12, P10, R17
Rotirende Achsenlager A15, F7
Schiffsbauer R14
Schleitmaschinen G10, L15
Schmiedstücke M31
Schmiedepressen R18
Schmierapparate T1
Schraubentakel W7
Schmieroel R10, W1
Schmirgel und Schmirgelräder ... B23, L15
Schreibmaschinen... ... ... E8, S25, W11
Spule und Schützemacher ... W16
Stahl-Konvertirer und Schmelzer S20
Stahl und Eisen Röhren... ... L12
Stahl und Eisenhütten Anlage ... B5
Treibriemen C22, F7, L2, R20
Ventilklappenfabrikanten ... G16
Verdämpfer M31
Vorwärmer des Speisewassers ... M27
Wasserbehälter B29
Werkzeugstahl S20
Zeichen- und Erdmessungsinstrumente A7, M28
Zuckermaschinen M3

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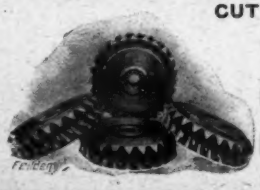

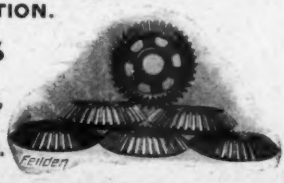

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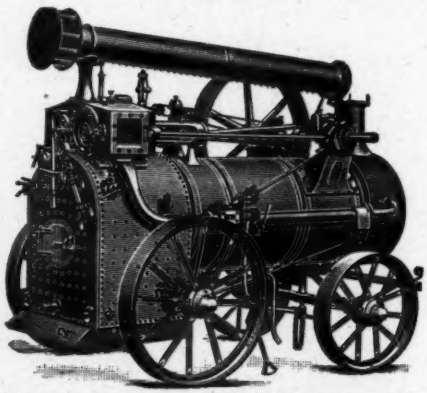

This illustration represents a 12 (Nominal) H.P. COMPOUND Portable Engine, fitted with high-speed sensitive Governor capable of developing 30 brake H.P. in normal work. Coal consumption (with maximum load) 2·77 lbs. of coal per brake H.P. per hour.

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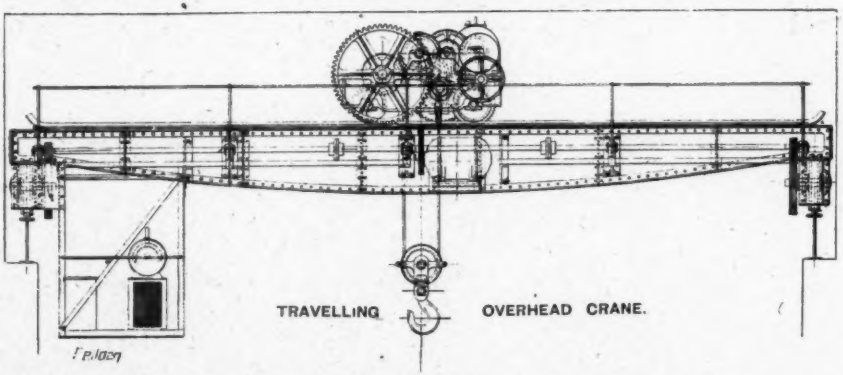

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The numbers against the names refer to the corresponding numbers against the Specialities on pages iii, v, vii.

FEILDEN'S MAGAZINE: Annuaire de l'Acheteur.
Les numéros en regard des noms se rapportent aux numéros correspondants en regard des Spécialités aux pages iii, v, vii.

FEILDEN'S MAGAZINE: Des Käufers Rathgeber.
Die Nummern neben den Namen beziehen sich auf die betreffenden Nummern neben den Specialitäten auf Seiten iii, v, vii.

List of Codes:

1. A1.
2. A B C.
3. Engineering.
4. Moreing's.
5. Moreing and McCutcheon's.
6. Lieber's.
7. Hawke's Premier.
8. Unicode.
9. Bedford McNeill's.
10. Ager's.
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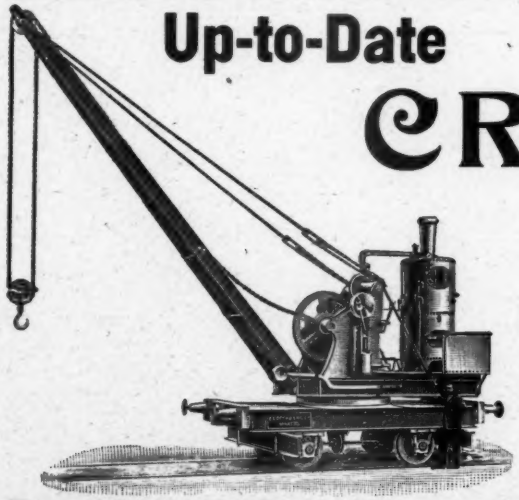

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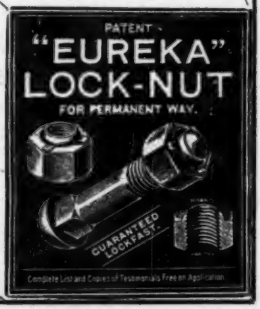

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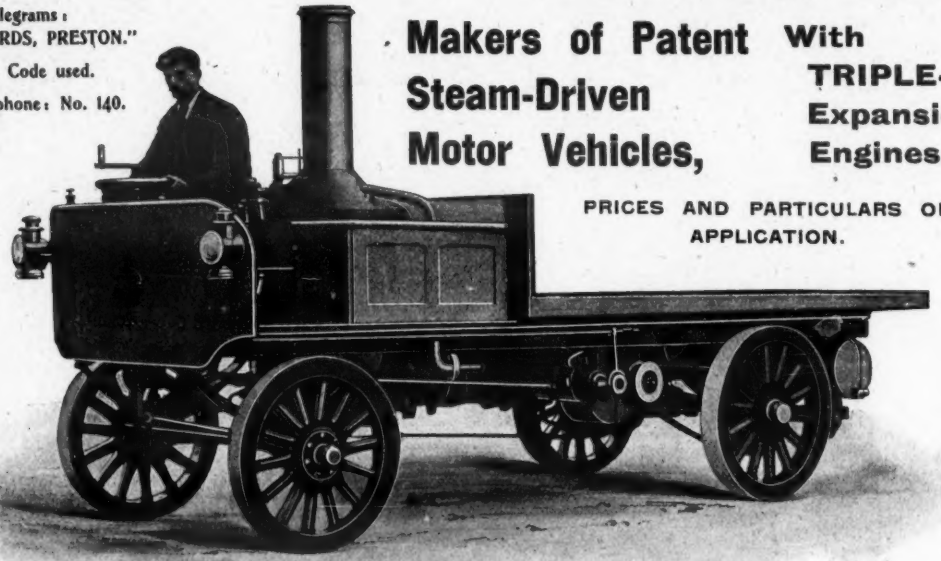

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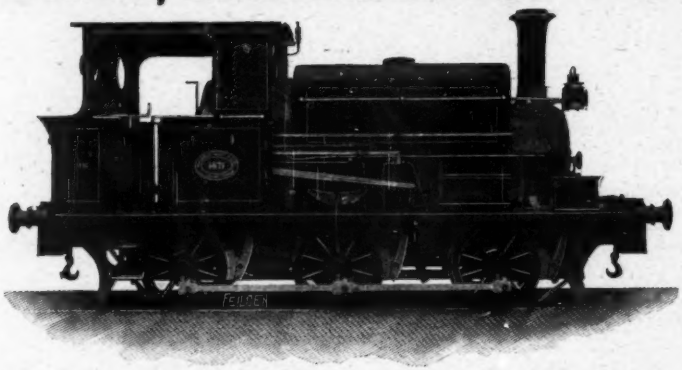

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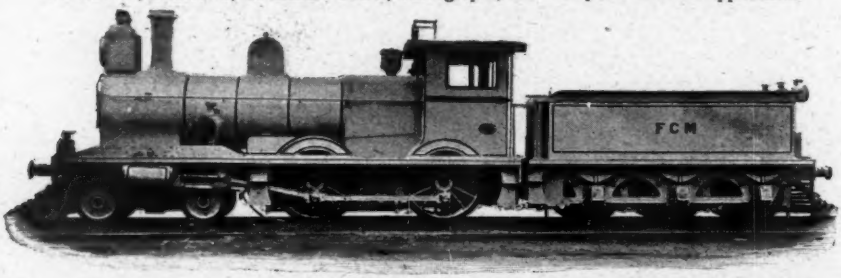

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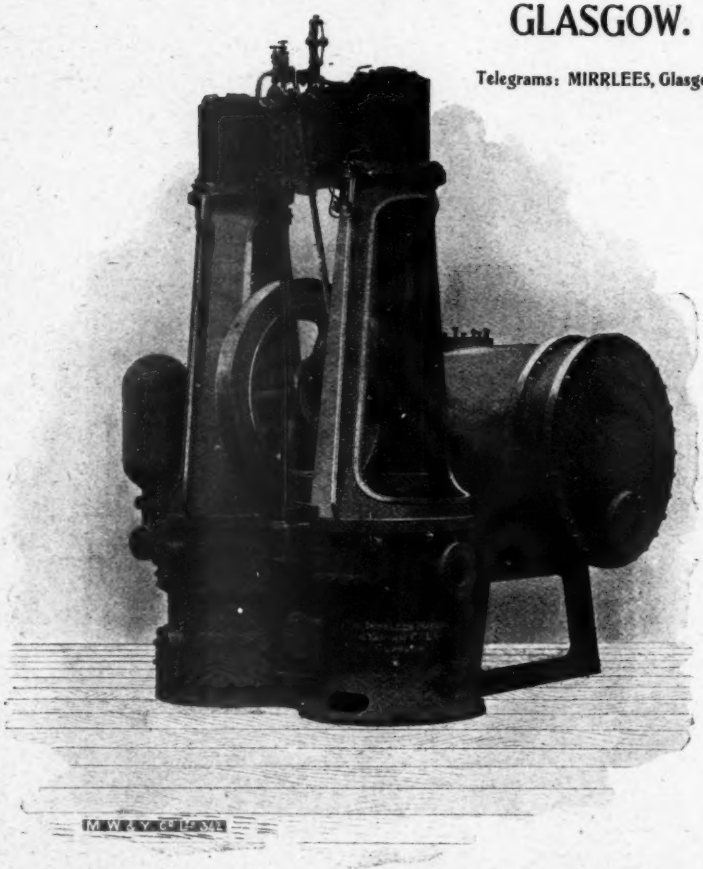

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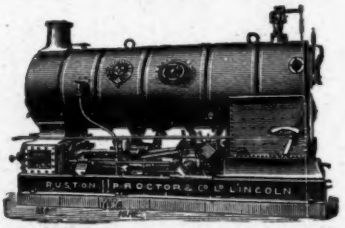

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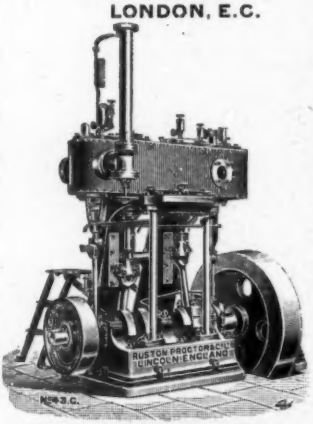
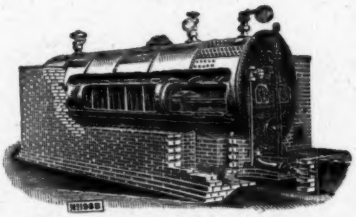


SIMPLE and COMPOUND VERTICAL STEAM ENGINES



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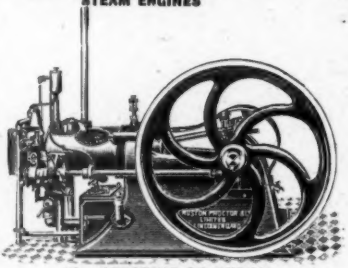

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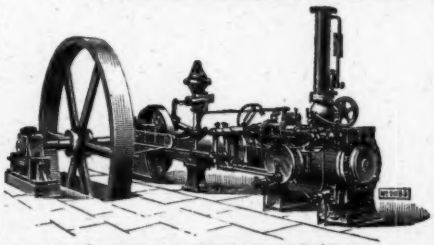

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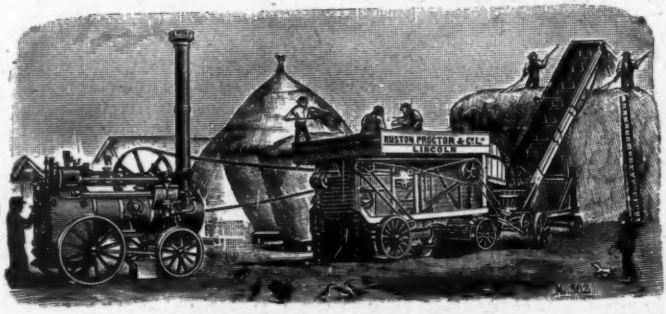

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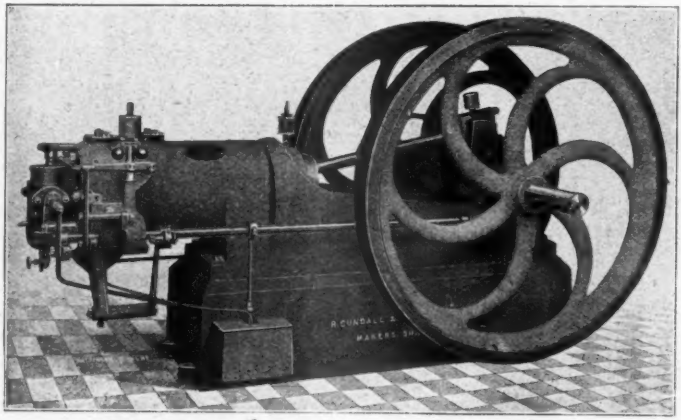

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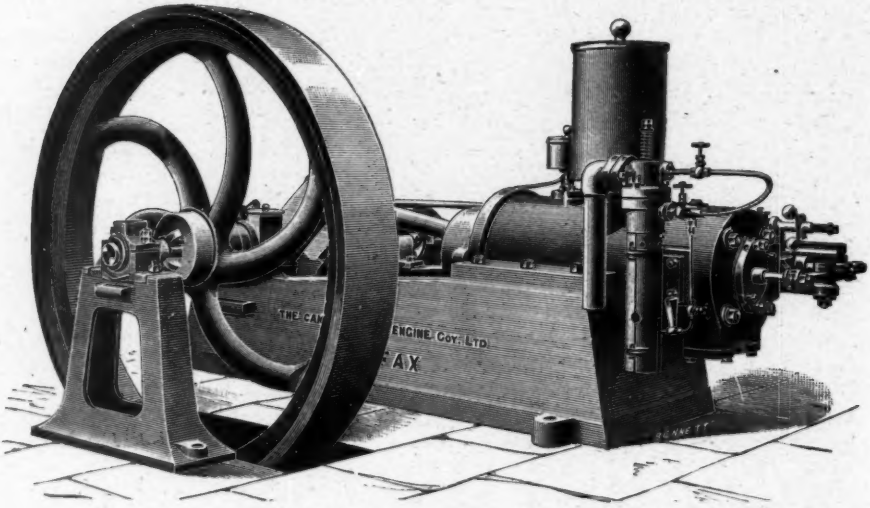

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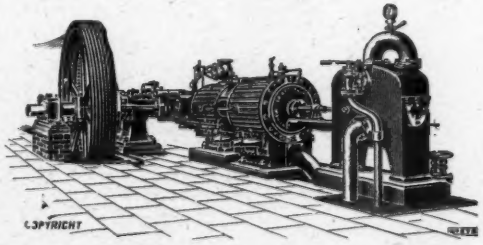

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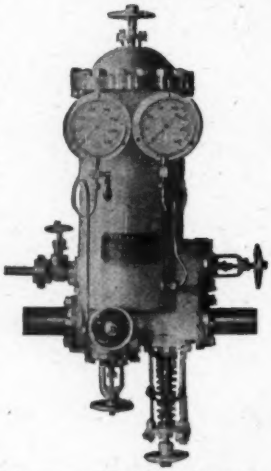

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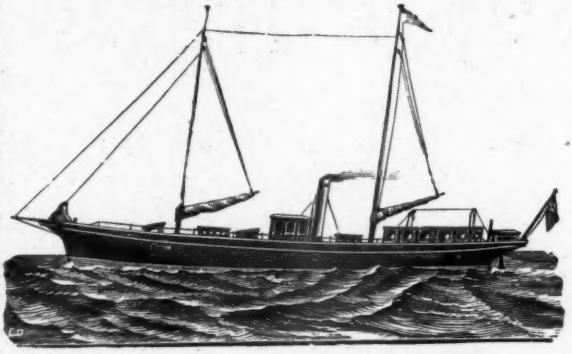

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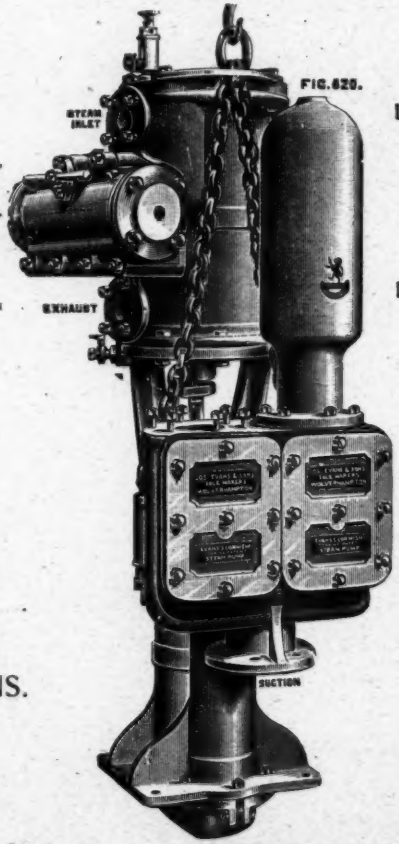

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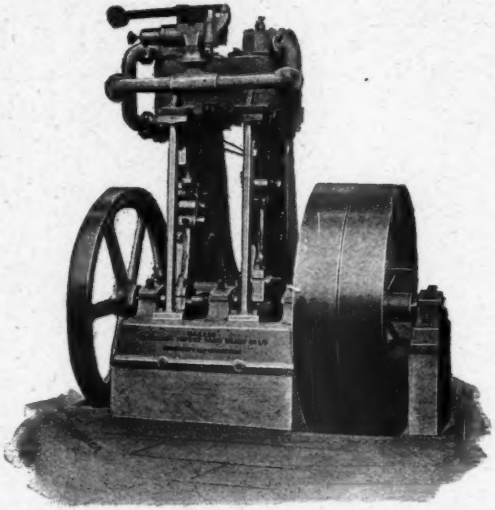

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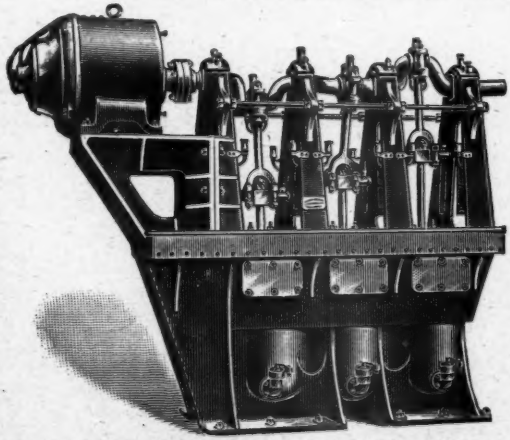

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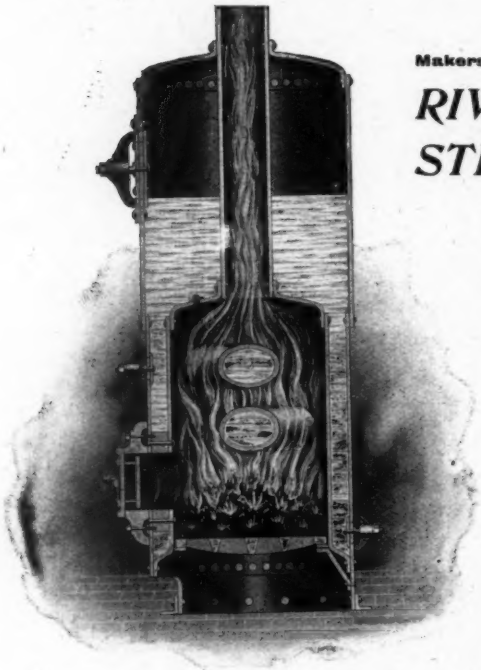

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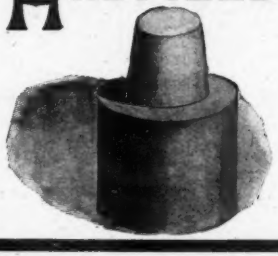

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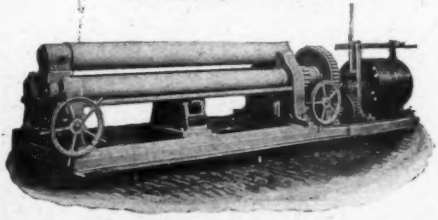

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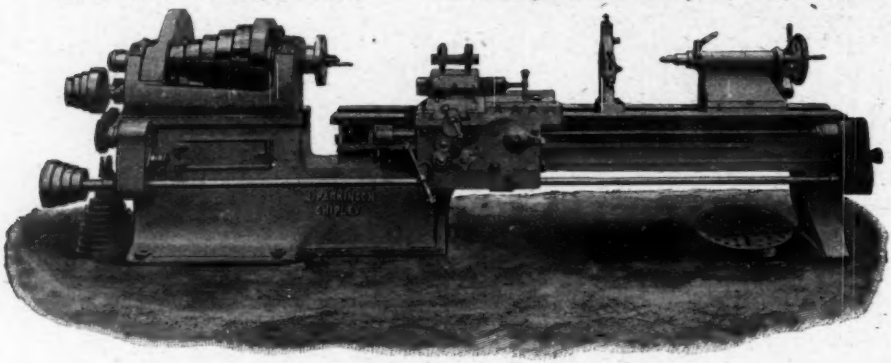

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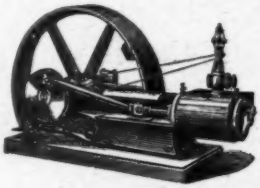

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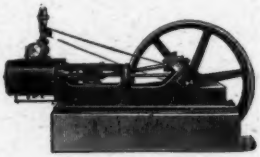

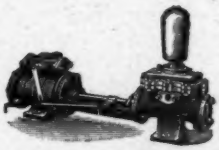

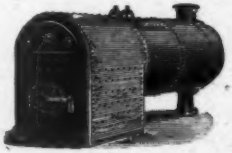

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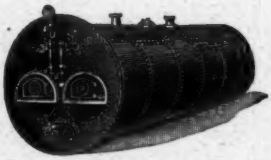

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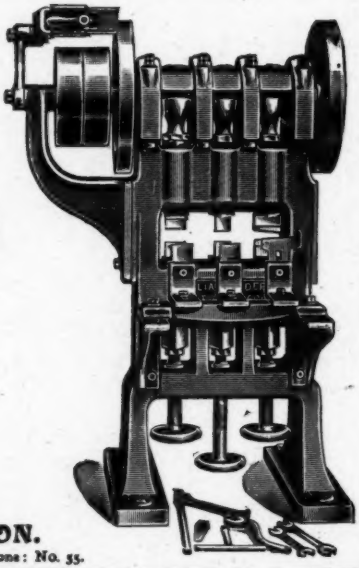

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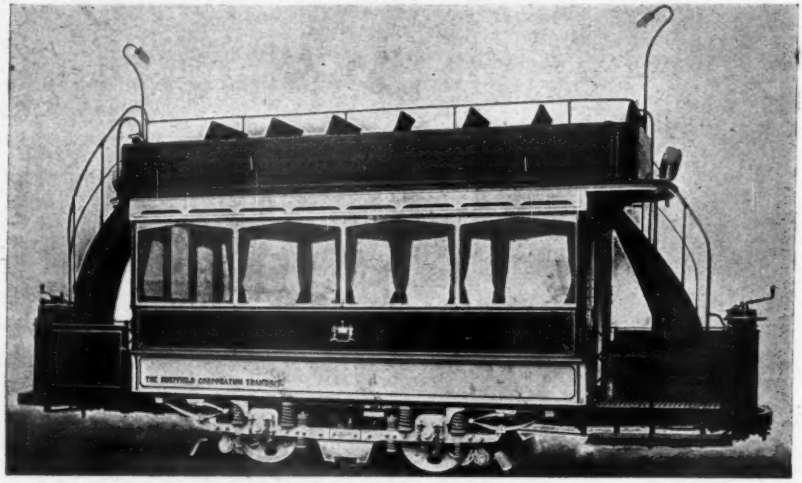

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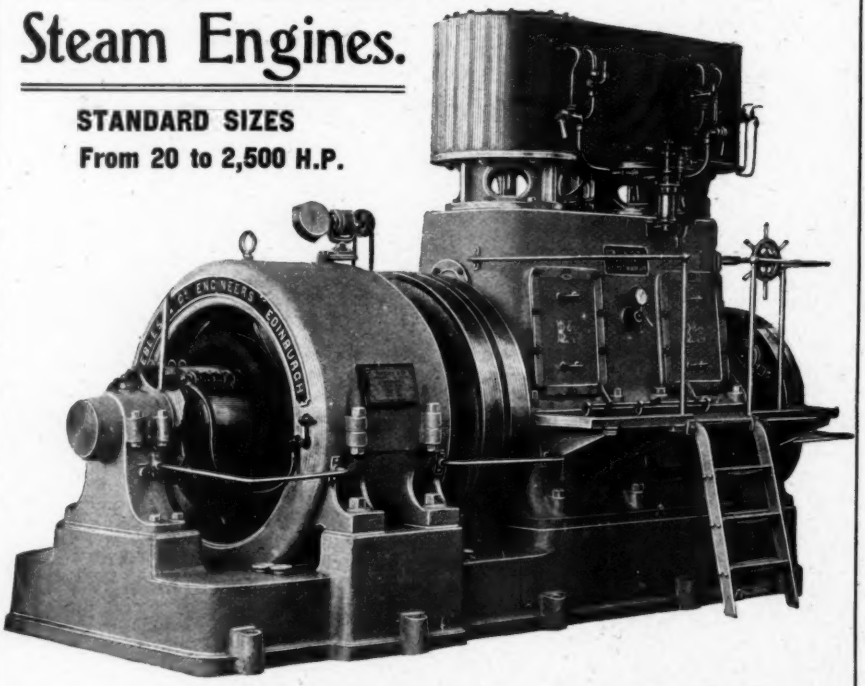

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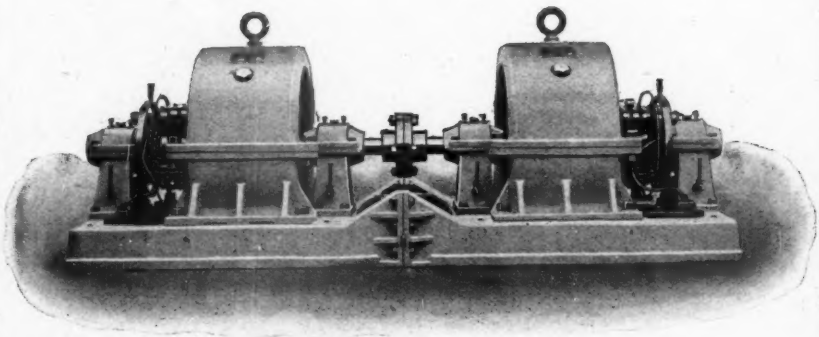

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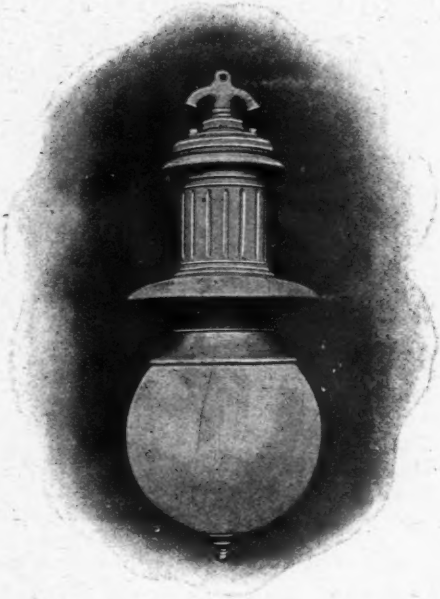

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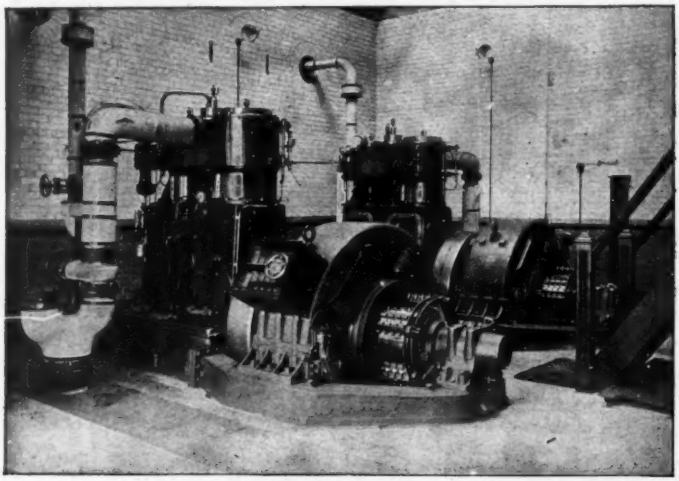

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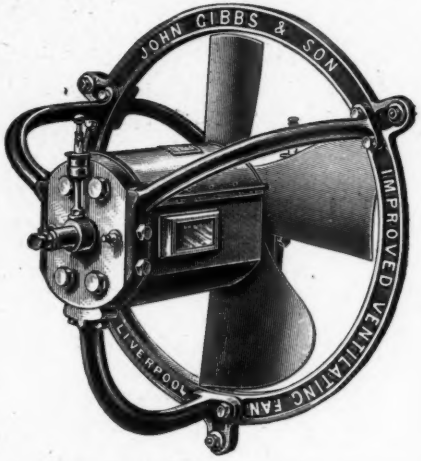

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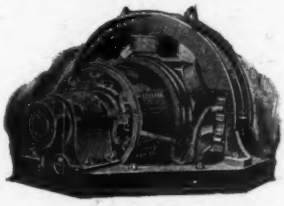

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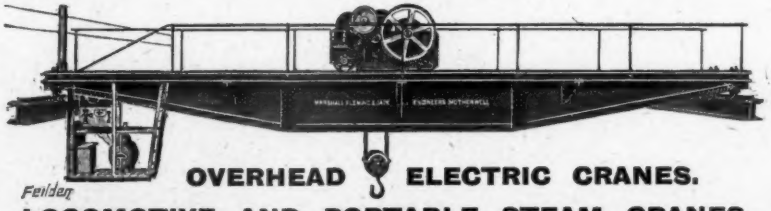

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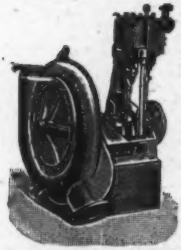

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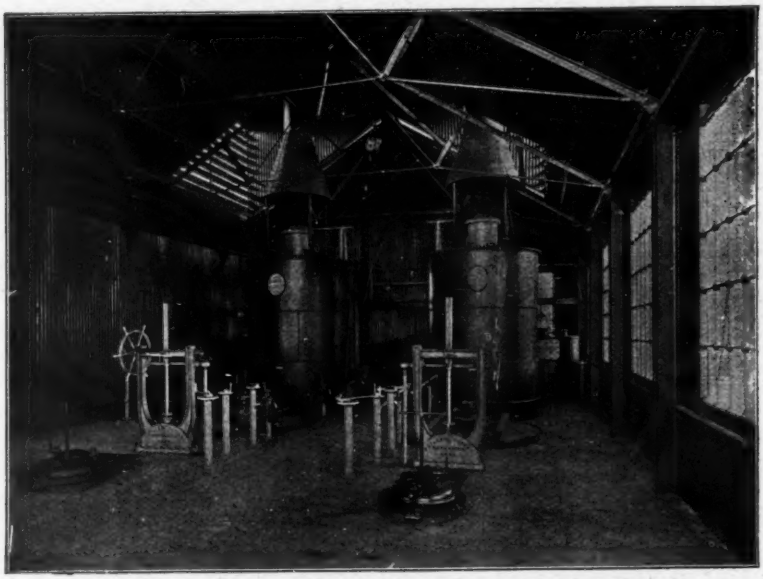

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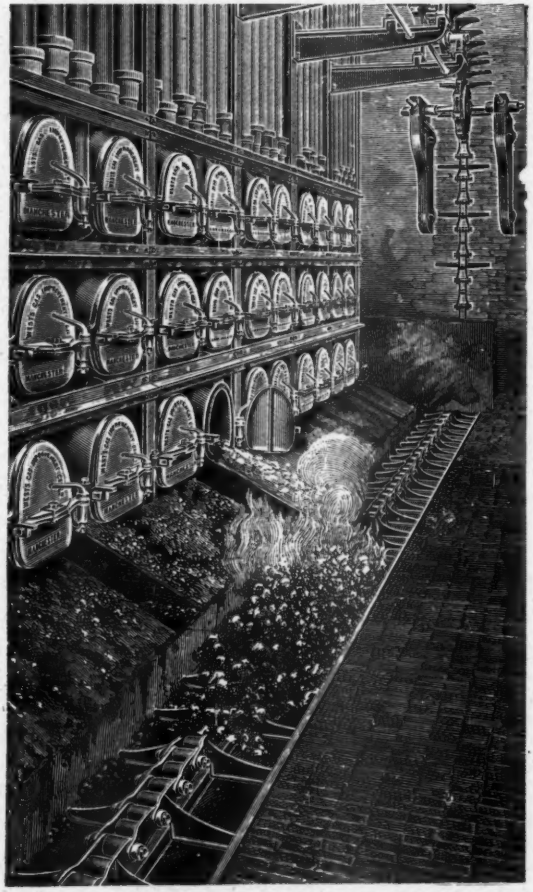

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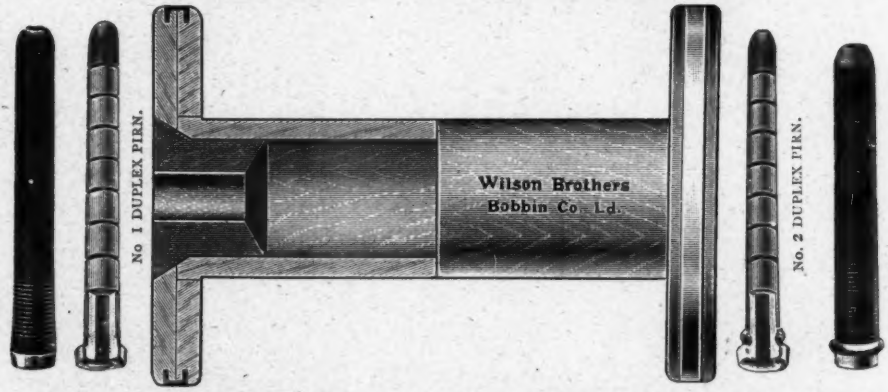

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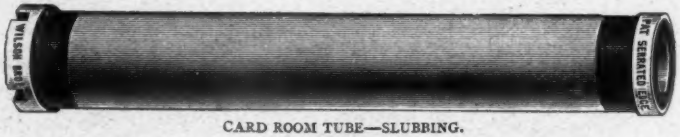

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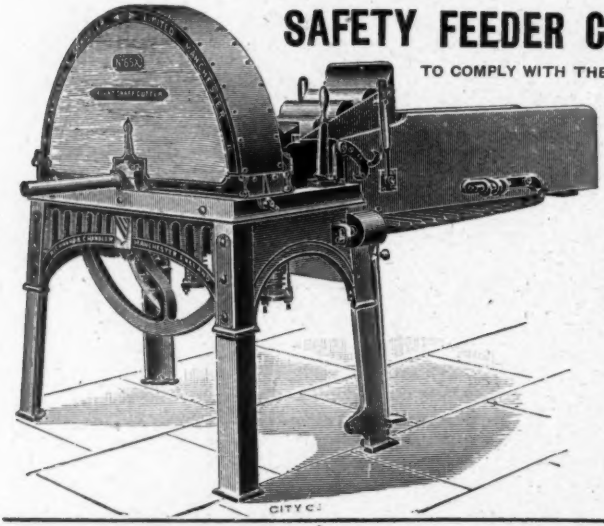

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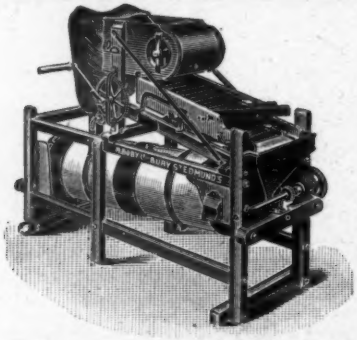

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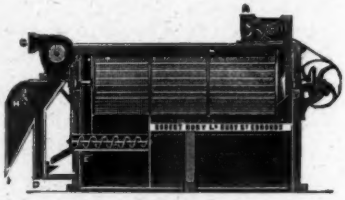

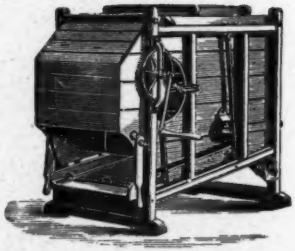

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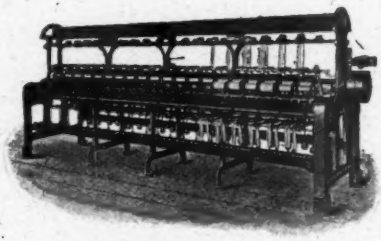

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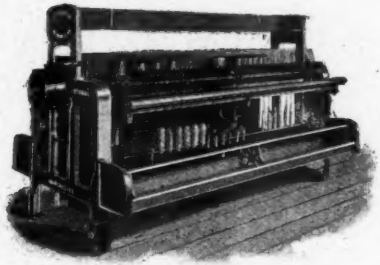

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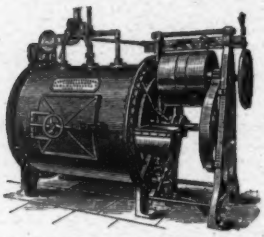

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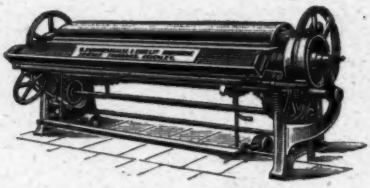

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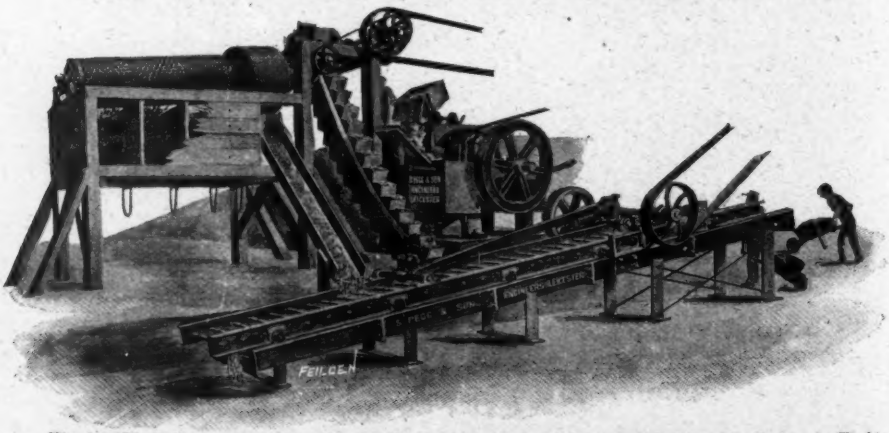

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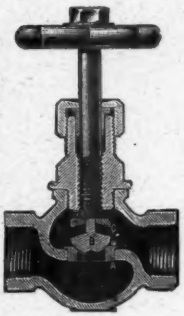

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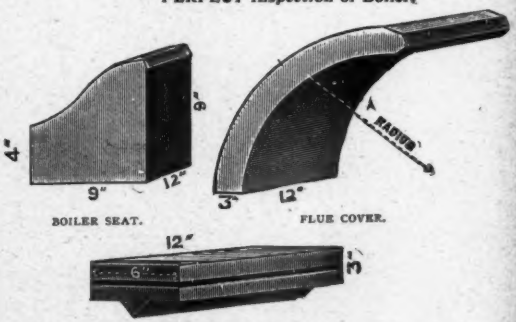

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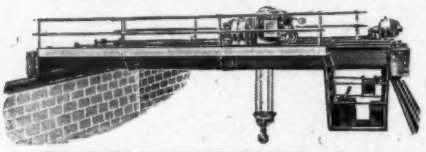

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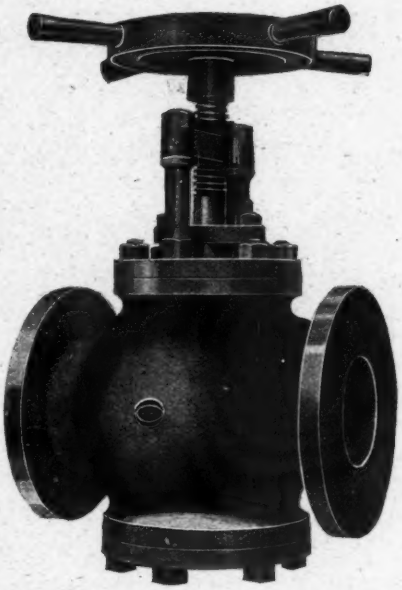

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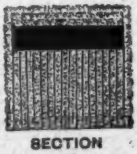

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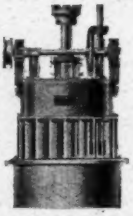

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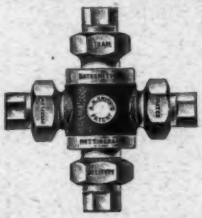

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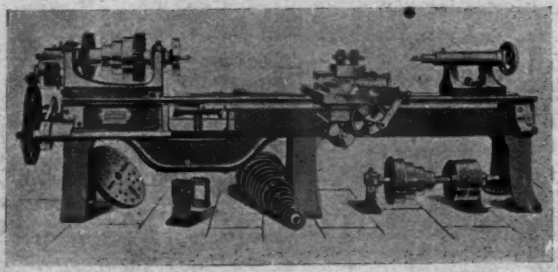

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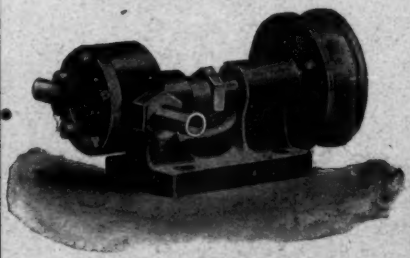

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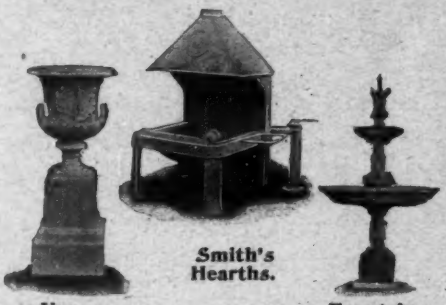

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